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## *Skolomystax*, a new genus for the Australian species formerly included in *Centroptilum* Eaton (Ephemeroptera: Baetidae)

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### Abstract

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A new genus, *Skolomystax* n. gen. is described to include the Australian mayflies previously assigned to the genus *Centroptilum* (Baetidae). Based on an integrated taxonomic analysis of mitochondrial cytochrome oxidase I and morphology, 12 species are assigned to this new genus, comprising two new combinations, *S. elongatus* (Suter, 1986) n. comb. and *S. collendus* (Harker, 1957) n. comb., and ten new species described in the nymphal stage: *S. brevis* n. sp., *S. chionotos* n. sp., *S. dyarrii* n. sp., *S. gippslandicus* n. sp., *S. goorudensis* n. sp., *S. hawkingi* n. sp., *S. leichhardti* n. sp., *S. paschei* n. sp., *S. tasmaniensis* n. sp., and *S. vulgaris* n. sp. A species known only from the original description by Harker (1957) is assigned as *S. collendus* n. comb.; the type material is lost, so it is not treated in detail and its validity remains uncertain. Adults of *S. elongatus*, *S. hawkingi* n. sp. and *S. leichhardti* n. sp. are also included.

*Skolomystax* is closely related to *Apobaetis*, *Callibaetis*, *Callibaetoides* and *Waltzophyphus*, but differs from them in the combination of a wide notch in the labrum with a basal pair of denticles, 3-segmented maxillary palps, hind wing pads present, and single gills without folds.

A key to the nymphs of all species of *Skolomystax*, except *S. collendus*, is given.

### Keywords

Mayflies, Baetidae, Taxonomy, COI, integrative taxonomy

### Introduction

The initial concept of the genus *Centroptilum* Eaton 1869 was very broad and included all Baetidae with hind wings and single marginal intercalaries in the forewings. Revisionary work in recent decades has shown that concept to be highly polyphyletic (Gattolliat et al., 2008; Gillies, 1990; Kluge and Novikova, 1992) and numerous new genera have been established, especially in Afrotropical region (Gillies, 1990; Lugo-Ortiz and McCafferty, 1996a, 1996b, 1998; Wuillot and Gillies, 1993, 1994). More recently, all Nearctic and Eastern Palearctic species of *Centroptilum* were transferred to *Anafroptilum* Kluge, 2011 (for the species without patella-tibial suture on forelegs of nymphs) or to *Procloeon* Bengtsson, 1915 (for the species with spines on the lateral margins of abdominal segments VIII–IX and greatly enlarged spines on outer margin of cerci). The present concept of *Centroptilum* includes species having a convex mesonotal

suture, single marginal intercalaries in the forewing, and hindwings present or absent, if present then usually with two unforked longitudinal veins, a single hooked costal process and a pointed apex. The nymphs have a small U-shaped median notch in the labrum, deeply cleft incisors on the left mandible with setae between the prostheca and molar region, three segmented maxillary palps with the third segment subequal to or longer than the second segment, truncate labial palps, pointed glossae and paraglossae, patella-tibial suture present on all legs, an arc of setae near the patella-tibial suture, relatively long, straight claws with two similar rows of denticles, gills with a single lamella, abdominal terga without lateral spines, and outer margin of cerci without greatly enlarged spines (Kluge and Novikova, 1992; Kluge, 2011). Therefore, *Centroptilum* now only encompasses three species from the Palearctic region (*C. luteolum* Müller 1776, *C. pirinense* Ikonov 1962 and *C. volodymyri* Martynov, Godunko and Palatov 2022, in Martynov

et al., 2022). The genus is now considered absent from Nearctic, Afrotropical and Oriental realms. The case of the Australian species previously assigned to *Centropitulum* is treated herein.

In Australia, *Centropitulum* was first reported by Harker (1957) when she described *C. collendum* Harker 1957 from male subimagines and nymphs collected along the central coast of New South Wales. Suter (1986) later described all life stages of *C. elongatum* Suter 1986 from streams in eastern South Australia (SA) and western Victoria (Vic). Morphological and molecular analyses of nymphs of *C. elongatum* and several undescribed Australian species indicates that they are not congeneric with *Centropitulum* (Webb and Suter, 2011) and they lack the defining characteristics of *Centropitulum sensu stricto*, such as the convex mesonotal suture, nymphs with a small U-shaped median notch in the labrum, and mandibles with setae between the prostheca and molar region, and share several unusual characters. Webb and Suter (2011) also provided a key for the nymphs of *C. elongatum* and nine morphospecies. In this paper, we describe a new genus for the Australian species, describe ten new species, and hypothesise their relationships based on molecular and morphological characters.

## Methods

Specimens used for molecular analyses were preserved in 95–100% ethanol. Total genomic DNA was extracted using a proteinase-K/Chelex solution. Tissue (either whole nymphs, one or two legs, or thoracic muscle) were placed in 100 µl of Chelex solution (containing 5% Chelex [weight/volume], 0.2% sodium dodecyl sulfate, 10 mM Tris pH 8, 0.5 mM Ethylenediaminetetraacetic acid) and 10 µl of 20 mg/ml proteinase-K. Samples were incubated overnight at 55°C. After incubation, the cleared specimens were removed and mounted on a microscope slide with Euparal and Cellosolve. Extractions were then centrifuged for 5 minutes at 1500 rpm and incubated for 5 minutes at 95°C to deactivate the proteinase-K. A portion of the DNA extraction was diluted 1 in 5 with 1X TE and used for subsequent analyses to reduce the number of freeze/thaw cycles and chance of contamination of the original extraction. All samples were stored at 20°C.

Polymerase chain reaction (PCR) was used to amplify fragments of the mtDNA locus cytochrome oxidase I (COI) using the primers LCO1490 and HCO2198 (Folmer et al., 1994). GenBank and specimen accession numbers are in Supplementary Table 1. PCR for COI reactions were performed using Platinum Taq (Invitrogen) and consisted of 3.5 µl buffer, 17.5 µl 10% w/v trehalose, 0.7 µl dNTPs, 1.75 µl 50 mM MgCl<sub>2</sub>, 0.7 µl of each primer, 0.125 µl taq polymerase, 0.01–5 µl of DNA template, and water to 35 µl. The PCR thermal regime followed that of Webb and Suter (2010). Results were visualised on 1.0% agarose gels stained with SybrSafe (Invitrogen). PCR products were purified and sequenced in both directions by Macrogen Inc. (Seoul, Korea).

Contigs were assembled using DNA Baser v2 (www.dnabaser.com) and manually aligned in MEGA11 (Tamura et al., 2021). All trace files were examined manually for evidence of possible multiple gene copies. COI p-distances were calculated in MEGA11. A maximum likelihood phylogenetic reconstruction with 100 bootstrap replicates was performed in MEGA 11 using the TN+G model, as selected by the model-test module within MEGA 11. Outgroups included *Callibaetis* sp., *Centropitulum luteolum*, *Neocloeon triangulifer* (McDunnough, 1931), and *Offadens* sp1.

Illustrations were prepared with a DinoEye Eyepiece camera using a Zeiss Axiolab microscope using both phase contrast and differential interference contrast to obtain the best images. Depth of field was achieved with multiple photographs which were stacked using Helicon Focus Ver. 7.6.1 (Helicon Soft Ltd 2000). These images were used to prepare line drawings. Measurements of individual segments or structures were made using an eyepiece graticule. The labrum notch angle was determined by drawing lines along the edge of the margins of the notch to intersect near the base; the angle was then measured with a protractor. Segment ratios of palps are given as segment I (length in mm): segment II length/segment I length: segment III length/segment I length and the leg ratios are femur length (length in mm): tibia length/femur length: tarsal length/femur length.

Table 1. Genetic divergence (p-distance) within and between nine species of *Skolomystax*.

Values in bold represent maximum intraspecific distances; values below the diagonal are minimum interspecific distances between pairs of species.

Minimum interspecific /Maximum intraspecific	<i>brevis</i>	<i>chionotos</i>	<i>dyarri</i>	<i>elongatus</i>	<i>gippslandicus</i>	<i>hawkingi</i>	<i>leichhardti</i>	<i>tasmaniensis</i>	<i>vulgaris</i>
<i>brevis</i>	<b>0.005</b>								
<i>chionotos</i>	0.181	<b>N/A</b>							
<i>dyarri</i>	0.193	0.177	<b>0.016</b>						
<i>elongatus</i>	0.181	0.142	0.17	<b>0.017</b>					
<i>gippslandicus</i>	0.19	0.186	0.161	0.161	<b>N/A</b>				
<i>hawkingi</i>	0.198	0.196	0.18	0.167	0.172	<b>0.018</b>			
<i>leichhardti</i>	0.19	0.178	0.183	0.164	0.175	0.17	<b>N/A</b>		
<i>tasmaniensis</i>	0.186	0.09	0.178	0.129	0.181	0.174	0.172	<b>0.015</b>	
<i>vulgaris</i>	0.187	0.102	0.186	0.134	0.186	0.181	0.17	0.052	<b>0.043</b>



Table 2. Morphological character matrix comparing the species of *Skolomystax*.

Species/ Character	<i>S. elongatus</i>	<i>S. brevis</i>	<i>S. paschei</i>	<i>S. hawkingi</i>	<i>S. leichhardtii</i>	<i>S. gippslandica</i>	<i>S. dyarhi</i>	<i>S. chionotos</i>	<i>S. tasmaniensis</i>	<i>S. vulgaris</i>	<i>S. goorudensis</i>
Spines on outer margins of Tibiae & tarsi	F Tib 3–17 F Tars 0–8 M Tib 3–17 M Tars 0–5 H Tib 4–20 H Tars 0–6	5–8 1–2 4–6 2–4 4–8 0–2	21 0 30 2 10–27 0–2	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
Dark brown markings on head, mandibles and labrum	No	Yes	No	No	No	No	No	No	No	No	No
Sternite spines on segments	III–IX long and alternating short spines contiguous	V–IX conical spines contiguous	II–IX III–IX long and alternating short spines, contiguous	IV–IX conical spines contiguous	V–IX long and contiguous	VI–IX long and contiguous	VI–IX VII–IX long and contiguous, rare short spines	IV–IX long and contiguous	IV–IX long, contiguous	IV–IX V–IX long, contiguous	IV–IX long and alternating short spines contiguous
Tergite spines	Long and alternating short	All long widely spaced	Long and alternating short	Long, widely spaced	Long, widely spaced	Long, widely spaced	Long and contiguous	Long, widely separated	Long, widely separated	Long, widely separated	Long, widely separated
Body with numerous small spots	No	No	No	Yes	Yes	No	No	No	No	No	No
Labrum notch margins	Deep, rectangular Angle 100°	Deep, rectangular Angle 105°	Shallow square, Angle 132°	Deep, rectangular Angle 96°	Deep, notch rounded Angle 107°	Deep, rectangular Angle 91°	Deep, rectangular Angle 117°	Deep, rectangular Angle 95°	Deep, rectangular Angle 106°	Deep, rectangular Angle 103°	Deep, rectangular Angle 93°
Left Mandible teeth on inner margin of outer incisors	3–4	3	4–5	1	1–4	2	4	4–5	3–6	2–5	1–3
Left Mandible inner margin of inner incisors	Broad, rugose	Broad, smooth	Broad, rugose	Rugose	2–4, rugose	2–3, smooth	Broad slightly rugose	Broad, slightly rugose	Broad, rugose	Broad, rugose	Broad, rugose
Right Mandible teeth on inner margin of inner incisors	0	0	0	0	0–1	0	0	0	0	0–2	3–5

Species/ Character	<i>S. elongatus</i>	<i>S. brevis</i>	<i>S. paschei</i>	<i>S. hawkingi</i>	<i>S. leichhardtii</i>	<i>S. gippstandica</i>	<i>S. dyarbi</i>	<i>S. chionotos</i>	<i>S. tasmaniensis</i>	<i>S. vulgaris</i>	<i>S. goorudensis</i>
Right Mandible teeth on outer margin of outer incisors	0	0	0	1	0	0	0	0	0	0	0
Maxillary palp segment I long or short	Long, extends to apical 1/3 of galea-lacinia	Long extends to apical 1/3 of galea- lacinia	Short, extends to mid 1/3 of galea-lacinia	Long, extends to apical 1/3 of galea- lacinia	Short, extends to mid 1/3 of galea-lacinia	Long, extends to apical 1/3 of galea-lacinia	Long, extends to apical 1/3 of galea- lacinia	Long almost extend to apex of galea- lacinia	Long, extends to apical 1/3 of galea-lacinia	Long, extends to apical 1/3 of galea- lacinia	Long extend to near apex of galea- lacinia
Maxillary palp total length	Beyond apex of galea- lacinia	Well beyond apex of galea-lacinia	Well beyond apex of galea-lacinia	Well beyond apex of galea- lacinia	Just beyond apex of galea-lacinia	Well beyond apex of galea-lacinia	Well beyond apex of galea- lacinia	Well beyond apex of galea- lacinia	Well beyond apex of galea-lacinia	Well beyond apex of galea- lacinia	Well beyond apex of galea-lacinia
Maxillary palp segment I + II length	Extends beyond apex of galea- lacinia	Extends beyond apex of galea- lacinia	Extends beyond apex of galea- lacinia	Extends beyond apex of galea- lacinia	Does not extend beyond apex of galea- lacinia	Extends beyond apex of galea- lacinia	Extends beyond apex of galea- lacinia	Extends beyond apex of galea- lacinia	Extends beyond apex of galea- lacinia	Extends just beyond apex of galea- lacinia	Extends beyond apex of galea- lacinia
Maxillary palp segment III length cw segment I	Approx equal	Shorter	Shorter	Shorter- longer	Longer	Shorter	Shorter	Shorter, half length of basal segment	Shorter	Shorter- longer	Shorter
Maxillary palp segment II length cw segment III length	Shorter	Shorter	Shorter	Shorter	Shorter	Long, equal to apical segment length	Shorter	Longer than apical segment length	Shorter to equal	Shorter	Shorter
Fore femur setae on outer margin	13–24	8–26	39	20–24	11–12	6	16	23	7–30	12–23	16–17
Fore femur setae on inner margin	4–30	5–11	37	10–18	14	11	17	34	2–24	10–17	13–16
Mid tibia with setae on outer margin	3–17	4–6	30	0	0	0	0	0	0	0–1	0
Mid tibia with setae on inner margin	8–22	9–13	30	7–10	0–5	18	10–12	24	9–18	6–19	12–32
Hind tarsus setae on inner margin	19–24	9–17	33–35	13–17	7–11	21–31	20–21	24–27	17–35	15–27	21–26

Species/ Character	<i>S. elongatus</i>	<i>S. brevis</i>	<i>S. paschei</i>	<i>S. hawkingi</i>	<i>S. leichhardtii</i>	<i>S. gippslandica</i>	<i>S. dyarbi</i>	<i>S. chionotos</i>	<i>S. tasmaniensis</i>	<i>S. vulgaris</i>	<i>S. goorudensis</i>
No. of paraproct spines	17–25	12–17	21–23	14–18	10–11	16–24	16–19	19–21	11–25	18–22	22
Abdominal segment I	Dark	Dark	Light	Numerous black spots	Numerous black spots	Dark antero-medially	Light	Light	Dark anteriorly	Dark	Light
Abdominal segment II	Dark	Dark central medial Y-shaped mark	Light	Numerous black spots	Numerous black spots	Light	Light	Light	Light	Dark	Light
Abdominal segment III	Dark	Light	Shaded	Numerous black spots	Numerous black spots	Light	Light	Light	Light	Light	Light
Abdominal segment IV	Light	Light	Shaded	Numerous black spots	Numerous black spots	Light	Light	Light	Light	Light	Light
Abdominal segment V	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Abdominal segment VI	Dark	Dark	Dark	Dark anterior	Dark anterior	Light	Dark	Light	Dark	Dark anterior half	Dark
Abdominal segment VII	Light	Light	Light	Numerous black spots	Numerous black spots	Shaded	Light	Light	Light	Light	Light
Abdominal segment VIII	Light	Light	Light	Numerous black spots	Numerous black spots	Shaded	Light	Light	Light	Light	Light
Abdominal segment IX	Dark	Dark	Dark	Numerous black spots	Numerous black spots	Dark	Dark	Dark	Dark	Dark	Dark
Abdominal segment X	Light	Light	Dark	Numerous black spots	Numerous black spots	Light	Light	Light	Light	Light	Dark
Black stripe morph (Y/N)	Y	N	N	N	Y	N	N	N	N	N	N
Distribution	SA, VIC	SE QLD, N NSW	NSW	N QLD	NT	VIC	NSW	NE VIC	TAS	NSW, VIC	NSW

Specimen unique identifier included with materials examined include a laboratory database code (e. g. JWA413; PS420). The collectors of material are identified with initials as follows: JD, John Dean; JW, Jeff Webb; JHH, John Hawking; MHR, Monitoring River Health; PS, Phil Suter; EFR, Edgar Riek; DB, Dennis Black; AW, Alice Wells; PC, Peter Cranston; MH, Mike Halsey; SWC, State Water Commission; KH, Kent Horte; RT, Ron Thresher; ZB, Zac Billingham.

All types are deposited in the Australian National Insect Collection in Canberra (ANIC) and each ANIC reference code refers to an individual specimen. Other material is held at the La Trobe University collection in Albury/Wodonga, Vic (no deposition code indicated) or the Museum of Zoology Lausanne (MZL).

## Results

### Phylogenetic analysis

Morphological analysis recognised 11 distinct species (Table 2). Sequences of COI were obtained for 27 specimens representing nine of these species (Supplementary Table S1). The maximum likelihood reconstruction (fig. 1) showed strong support for each species, although the relationships among species were generally poorly supported. However, the morphologically similar species *S. tasmaniensis* n. sp., *S. vulgaris* n. sp. and *S. chionotos* n. sp. were strongly supported as monophyletic. The presumed sister species relationship between *S. hawkingi* n. sp. and *S. leichhardti* n. sp. was not recovered by our analysis but was when different methods and/or parameters were utilised (e. g. neighbour joining, not shown). Maximum intraspecific p-distances ranged from 0.5 to 4.3%, while minimum interspecific p-distances ranged from 5.2 to 19.8% (Table 1). The lowest interspecific p-distance was between *S. tasmaniensis* n. sp. and *S. vulgaris* n. sp. (5.2%).

### Skolomystax n. gen.

LSID urn:lsid:zoobank.org:pub:8746565B-0421-4D37-8A78-22C1AEAD6104

Type species: *C. elongatum* Suter 1986

*Skolomystax elongatus* (Suter, 1986) n. comb. by present designation

Species composition: *S. brevis* n. sp., *S. chionotos* n. sp., *S. collendus* (Harker, 1957) n. comb., *S. dyarrii* n. sp., *S. elongatus* (Suter, 1986) n. comb., *S. gippslandicus* n. sp., *S. goorudensis* n. sp., *S. hawkingi* n. sp., *S. leichhardti* n. sp., *S. paschei* n. sp., *S. tasmaniensis* n. sp., and *S. vulgaris* n. sp.

### Diagnosis

*Nymph*: wide notch in the labrum with a basal pair of denticles (figs. 2a, b). Mandibles with two completely separated sets of incisors, inner set twisted at right angles to outer, setae between prostheca and mola absent (figs. 4e–h, 6e–h, 8d–g, 10d–g, 12–g, 14e–h, 17e–h, 20a–d, 21d–g, 23d–g). Maxillae broad, crown with arched teeth almost indistinct from setae below; three rows of arched setae along the inner margin of lacinia, maxillary palp 3-segmented, segment I broad and curved, segments II and III slender, segment III equal to or longer than

segment II (figs. 2c, 4c, 6c, 8c, 10c, 12c, 14c, 17c, 19c, 21c, 23c). Segment II of labial palp lacking distomedial projection, segment III apically broad and slightly falcate (figs. 3a, 3b, 7a, 7b, 8h, 8i, 11a, 11b, 12a, 12b, 14i, 14j, 18a, 18b, 20e, 20f, 22a, 22b, 24a, 24b). Gills on abdominal segments I–VII with single lamella, gills on segments I and II curved and pointed; lateral margins of the abdominal segments lack spines.

*Adults*: forewings with single intercalary veins basal of MP (figs. 3b, 16a, 16b). Hindwings present, with two or three longitudinal veins (figs. 3c, 16b, 18d); costal process well developed in basal third (Suter, 1986: 388, fig. 23b; figs. 3c, 16b, 18d). Genital forceps 3-segmented, segment III long and narrow; area between bases of forceps without projection (Suter, 1986: 388, fig. 23d; fig. 3d).

### Description

*Nymph*: up to 11 mm in length.

*Head*: antennae ~ 0.3 x length of body.

*Mouthparts*: labrum square to slightly longer than wide, with wide notch with flat base and pair of small tooth-like projections basally (figs. 2a, 2b, 4a, 4b, 6a, 6b, 8a, 8b, 10a, 10b, 12a, 12b, 14a, 14b, 17a, 17b, 19a, 19b, 21a, 21b, 23a, 23b); dorsal surface with scattered fine setae, and row of long robust setae on distal margin; ventral surface with single row of fimbriate setae on anterior margin and scattered fine setae, those near anterior corners longer, and short pointed robust setae near lateral margin.

*Mandibles*: two sets of incisors completely separated, outer set with long and slender incisors; inner set rotated 90° relative to outer set; right mandible with outer incisors with three apical teeth, inner incisors with 2–3 apical teeth, fimbriate seta at apex of molar area (figs. 2d, 4e, 4g, 6d, 6f, 8d, 8f, 10d, 10f, 12d, 12f, 14e, 14g, 17e, 17g, 20a, 20c, 21d, 21f, 23d, 23f); left mandible with outer incisors with three apical teeth, inner margin with 1–6 lateral teeth, inner incisors with 2–3 apical teeth, inner margin expanded at base smooth to rugose; patch of fine setae at base of prostheca (figs. 2e, 4f, 4h, 6e, 6g, 8e, 8g, 10e, 10g, 12e, 12g, 14f, 14h, 17f, 17h, 20b, 20d, 21e, 21g, 23e, 23g); right mandible with prostheca slender and forked, mola highly developed, reducing distance between prostheca and mola; left mandible with thumb of mola in same plane as anterior margin.

*Hypopharynx*: lingua subrectangular, with distinct median ridge and apical projection; superlingua shorter than lingua and poorly expanded laterally (figs. 4d, 14d, 17d).

*Maxillae*: broad; crown with arched teeth almost indistinct from arched setae below, 3–6 thin setae at the base of crown in a row or scattered row; three rows of long stout arched setae on inner margin of lacinia, two stout feathered dentisetae, one bifurcate, as long as arched setae; one stout seta perpendicularly to margin and a row of 2–6 setae at base of lacinia; palp three segmented, longer than galealacinia, with rare to numerous long fine hair-like setae, segment I cylindrical and curved medially, broad and long; segments II and III slender (figs. 2c, 4c, 6c, 8c, 10c, 12c, 14c, 17c, 19c, 21c, 23c).

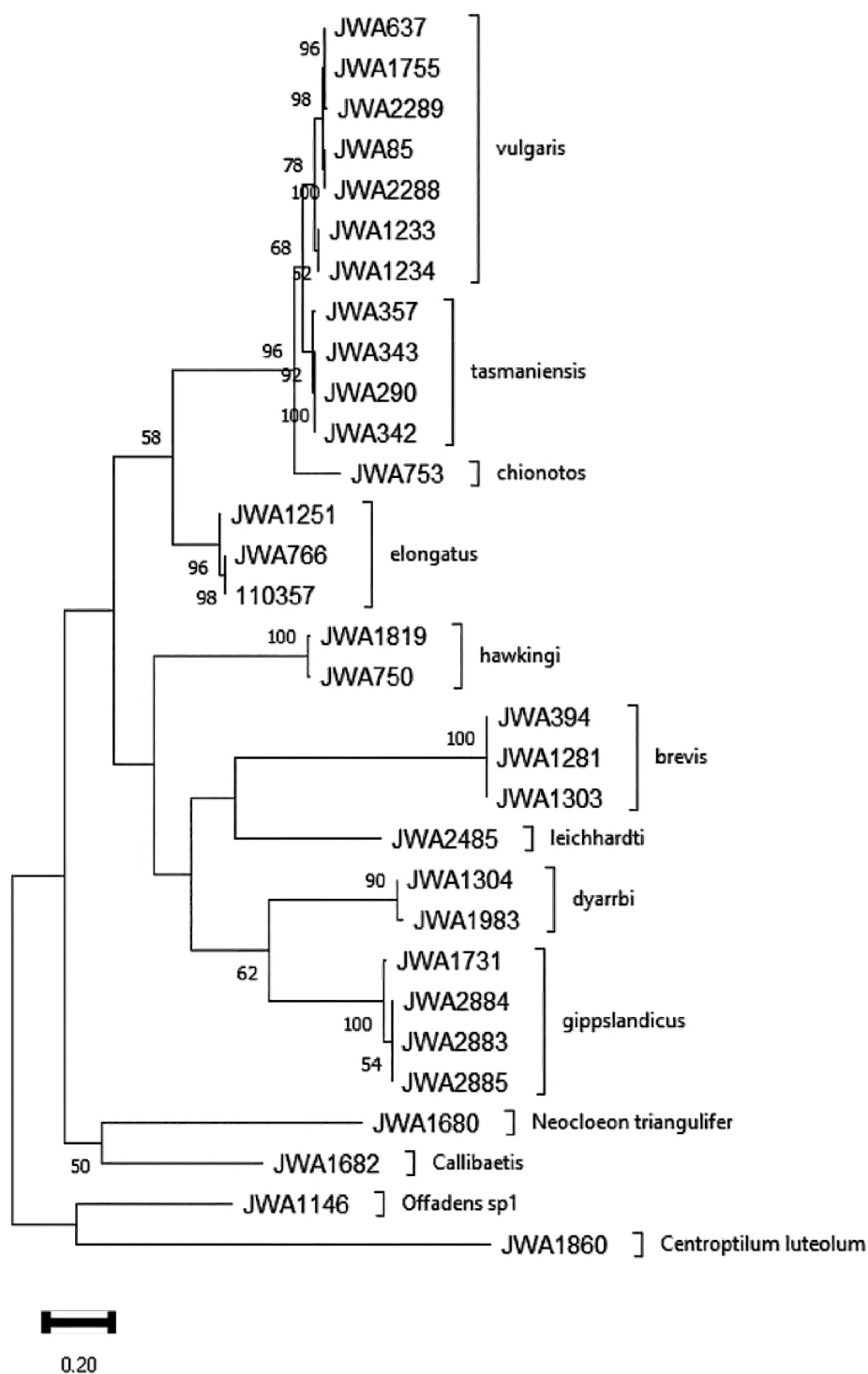


Figure 1. Maximum Likelihood phylogram of a 657 bp fragment of COI for nine species of *Skolomystax* and four outgroup taxa. Branch lengths represent the number of changes per site. Values above or below the branches represent bootstrap support.

**Labium:** glossae apically rounded or slightly truncate, slightly shorter than paraglossae, with single row of medium stout setae on margins, dorsal surface with single large fimbriate seta without distinct socket near apex, ventral surface with numerous long fine setae; paraglossae curved medially, truncate apically and with single row of long setae on outer margin, dorsal surface with numerous long setae and with dense apical patch of fine setae, ventral surface with numerous long fine setae; labial palp three segmented, outer margin of each segment with hair-like setae and lacking spines, segment I sub rectangular, segment II apically expanded and longer on outer margin than inner margin, dorsal surface with oblique row of fine setae distally, ventral surface with scattered hair-like; segment III broad subequal in width to segment II, subrectangular and slightly falcate, with numerous long robust and short fine setae on margins, dorsal surface with long robust setae distally, ventral surface with scattered hair-like setae (figs. 5a, 5b, 7a, 7b, 8h, 8i, 11a, 11b, 13a, 13b, 14i, 14j, 18a, 18b, 20e, 20f, 22a, 22b, 24a, 24b).

**Thorax:** much longer than wide; hindwing pads present.

**Legs:** long and slender; femora with short and stout setae on ventral and dorsal margin, villipore absent, with paired subapical setae; tibiae with tibiopatellar suture present on all legs and without arc of setae, tibiae and tarsi with outer margin with or without setae, inner margin with abundant medium stout setae; tarsal claws elongate and with two rows of abundant minute denticles increasing in length from base, apical setae absent (figs. 3a, 5c, 7c, 9a, 11f, 13c, 15a, 18d, 20g, 22c, 24c).

**Abdomen:** terga with numerous scales, scale bases and fine setae, posterior margins with triangular long and slender spines (figs. 2f, 2i, 7e, 9c, 11d, 13e, 15b, 17j, 19f, 22e, 24e). Sterna with scales, scale bases and numerous long fine setae, distal segments with spines on posterior margins, distal margins of sternites II–VI to IX with triangular spines depending on species (figs. 2g, 2j, 7f, 9d, 11e, 13f, 15c, 17k, 19g, 22f, 24f), distal margin of other sternites smooth. Lateral margin of terga without spines. Simple plate-like gills present on segments I–VII, well tracheated, margins smooth. Gills I and II narrow and curved away from abdomen, apically pointed; gills III–VII somewhat asymmetrically oval, with sclerotised margin; apically rounded. Three caudal filaments with dense intersegmental setae on median surfaces nearly to tip, with some segments more darkly coloured; articulations of cerci and terminal filament with whorl of spines, those on lateral surfaces of cerci generally longer than those on median surfaces; median caudal filament slightly shorter than cerci.

**Adult:** turbinate eyes of male nearly contiguous dorsally. Forewings with single intercalary veins basal of MP (fig. 3b), intercalaries anterior of MP single in described species, but double in some not yet associated with nymphs. Hindwings (figs. 3c, 16a, 16b, 18d) present, with two or three longitudinal veins, second vein forked or unforked; third longitudinal vein when present sometimes poorly developed and joining hind margin in basal third of wing; costal margin with well-developed costal process in basal third, without vein at base, variable in shape; crossveins present or absent. Abdomen terga variable, generally with extensive red markings, especially in females; sterna with

or without red spotting. Forceps 3-segmented, segments I and II mostly fused, segment III long and narrow (Suter, 1986: 388, fig. 22d; fig 3d). Cerci with fine setae, and every other articulation darkened, terminal filament reduced

## Discussion

Morphologically, *Skolomystax* may look superficially similar to *Centroptilum* (labial palp segment III apically broad and slightly falcated, elongated claw with two rows of abundant denticles, similar mandibles) but it can be easily separated by numerous characters such as the shape of the labrum, the shape of the hypopharynx, the shape and setation of the maxilla and at the imaginal stage by the shape and venation of the hindwing. *Skolomystax* is most similar to *Apobaetis* Day 1955, *Callibaetis* Eaton 1881, *Callibaetoides* Cruz, Salles and Hamada 2013 and *Waltzophyphus* Lugo-Ortiz and McCafferty, 1995. Cruz et al. (2013) noted that the newly described genus *Callibaetoides* from Brazil was most similar to *C. elongatum* (*S. elongatus*) from Australia. A recent study of the phylogeny of the Baetidae using morphological characters found *S. elongatus* was in a clade with *Callibaetis* and *Callibaetodes*, which was the sister group of a clade comprised of *Waltzophyphus* and *Apobaetis* (Cruz et al., 2020).

The five Baetidae genera share, for example, frontoclypeal suture at the level of the ocelli; scape and pedicel of antennae with cylindrical or subcylindrical setae; external margins of the mandibles convex; inner and outer incisors of mandibles not reduced in size; triangular process present between prostheca and molars on left mandibles; external margin of maxilla convex; maxilla with dense filtering setae on apex of galea-lacinia, with three maxillary canines; labial mentum not elongated; base of glossae not overlapping base of paraglossae; three-segmented labial palps; paraprocts and lateral extension with spines; fork MA1–MA2 absent; male foreleg with first segment of fore tarsus very short and tarsal claws similar; mid- and hind legs with four tarsomeres and tarsal claws different; paracercus vestigial and gonostylus with three segments.

*Waltzophyphus* and *Apobaetis* differ from the other three genera by having a median concavity on distal margin of labrum not deeply cleft and lacking a pair of denticles on median margin of labrum concavity; labrum width >2 x length; setae between prostheca and molars on mandibles restricted to base of prostheca; glossae longer than paraglossae; distomedial projection on labial palp segment II present; and thoracic mesosternum projection present.

*Callibaetis*, *Callibaetoides* and *Skolomystax* are unique in having a wide V-shaped notch with a pair of sclerotised denticles on the median margin of the labrum; small tooth laterally on the outer incisors, and a large single seta on the dorsal surface of the glossae (although this appears to be absent in some *Callibaetis*). *Callibaetis* nymphs differ from those of *Skolomystax* and *Callibaetoides* by having two-segmented maxillary palps, maxilla with spine-like setae on surface of maxillary palp; robust maxillary canines apically pointed; distal margin of paraglossae with a single row of setae; segment I of labial palps with spine-like setae; outer and inner margins of segment II of labial palps parallel and distal margin of

segment II oblique; and segment III quadrangular or globose and abdominal terga lacking scale-like setae/sockets.

*Callibaetoides* differs from *Skolomystax* in possessing very long antennae (3–3.5 x head width); protheca of left mandible stout with apical denticles; lacks a row of setae on inner margin of the glossae; many long fine-hair-like setae on outer margin of labial palp segments I and II; apex of labial palp segment III on external corner lacking pointed projection; median concavity on labial palp segment III absent; fore femur with blunt setae near dorsal margin on anterior surface; fore claw with denticles extending more than half length of claw; abdominal gill I asymmetric; abdominal terga surface shagreen; long spines on cerci every third segment, male forewing with double free marginal intercalaries; two longitudinal veins in hindwing of imago; and a well-developed centrally located sub-quadrangular costal process.

Baetidae adults are generally rather difficult to identify at the generic level because of the lack of reliable generic characters. *Skolomystax* can usually be differentiated from other adults of Australian Baetidae by the presence of hindwings and the single marginal intercalary veins on forewings basal of MP. The second longitudinal vein in the hindwing when forked has a single intercalary. The abdominal colour patterns, especially of the females, tend to be more complex than those of *Offadens*. At least one species of *Offadens* from northern Queensland (Qld) has single marginal intercalaries in the forewing of the females and may be confused with *Skolomystax*, but has multiple intercalaries in the forked second longitudinal vein of the hind wing.

**Etymology:** *Skolomystax* is masculine in gender and is a combination of the Greek words *skolops* (pointed or thorny) and *mystax* (lip) in reference to the pointed pair of denticles on the labrum.

**Distribution:** widespread in eastern mainland Australia from the Northern Territory (NT) to SA and Tasmania (Tas). There are reports of this genus occurring in central Australia, but we have not yet examined specimens. Nymphs occur mostly in sandy, depositional areas in a variety of stream types, including mountain streams below the tree line and temporary lowland streams.

***Skolomystax elongatus* (Suter, 1986) n. comb. (figs. 2, 25a)**

***Centropilum elongatum* Suter, 1986**

***Centropilum* spBlackstripe in Webb and Suter (2011)**

**Material examined.** *Holotype:* Wannon R above Wannon Falls, 37.68S 141.84E, 30 Oct 1977, PS.

**Nymph:** New South Wales (NSW): Site 10 Marowan Ck near Glencoe 29.933S 151.716E 26 Nov 1998 PS, JD, JWA1384; MacLaughlin R at Monaro Highway, south of Nimmitabel, JWA1251, 36.5722S 149.2847E, 29 Mar 2009, SA: Mosquito Ck, 37.09S 140.79E, PS Carrickalinga Ck, 35.43S 138.38E, PS; Deep Ck upstream of ford, 35.58S 137.25E, PS; Tent Rock Ck, Deep Ck Conservation Park, 35.633S 137.233E, PS; Kangaroo Island SA Breakneck R 35.93S 136.61E, PS; DeMole R 35.74S 136.79E, PS; Rocky R 35.95S 136.71E, PS; Southwest R 35.98S 136.86E, PS; Stunsail Boom R 35.99S 137.01E, PS; Western R 35.68S 136.97E, PS, MZL. Vic: Wannon R

above Wannon Falls, 37.68S 141.84E, 30 Oct 2007, PS: Jimmy's Ck, Mt Emu Ck, 38.22S 142.99E, PS; Wimmera R at Eversley 37.19S 143.17E, 28 Feb 1994; Eumerella R near Bessiebell JWA766 38.16S 141.95E, 9 Jul 2008, JW; Eumerella R on Princes Highway, JWA2510, 38.26S 141.94E, 19 Nov 2009, JW; Leigh River S of Ballarat at Mt Mercer, PS153, 37.89S 143.94E, 20 Apr 1994, PS; Grangeburn Ck at 30 Clifton Rd, Hamilton '110357', 37.5155S 141.980E, 4 Oct 2014 ZB.

### Nymph – description

**Body:** 8.0–9.8 mm; caudal filaments 0.37–0.59 times body length, terminal filament 0.45 times body length; antennae ~ 0.3 x body length.

**Head:** uniformly coloured, with some dark vermiculations on vertex. Antennae with scape 1.07–1.40 times length of pedicel.

**Mouthparts:** labrum 1.22–1.30 times wider than long (fig. 2a), labrum notch rectangular with a pair of small lateral projections (fig. 2b), notch angle 100°, notch depth 0.25–0.31 x notch width, 0.76–0.80 times labrum length; notch lined with 20–27 fimbriate setae on each side, ventrally with single row of fimbriate setae apically, numerous scattered fine setae, those at apical corners distinctly longer and more robust, and laterally with submarginal scattered row of 7–13 short robust setae; dorsally with numerous scattered long fine setae. Right mandible (planate) (fig. 2d) outer incisors with three apical teeth and inner margin smooth; inner incisor with broad surface and with three indistinct teeth; protheca slender and forked, with patch of fine setae at base. Left mandible (angulate) (fig. 2e) with three apical teeth and 3–4 teeth on inner margin of outer incisor; inner incisor with three apical teeth, inner incisor with broad rugose basal region on inner margin; protheca slender, simple with few long spines, and with patch of setae at base. Maxillae (fig. 2c) with 3–7 subcrest setae on ventral surface, 1–8 hump setae, and 30–36 lacinial setae, lateral margin below palp with numerous fine hair-like setae; maxillary palp length 0.28–0.45 mm; palp segment I somewhat curved and reaching beyond middle of galealacinia, with dense row of long fine hair-like setae on outer margin; segments II and III together 1.38–1.69 times longer than basal segment and extend beyond apex of galealacinia; segment II shorter than segment III, with numerous long fine hair-like setae; segment III approximately equal in length to segment I, with few long fine hair-like setae and with short fine hair-like setae at apex, 1.16–2.07 times segment II length; segment ratios of palp 1.00 (0.13–0.24 mm) : 0.48–0.67 : 0.78–1.11. Labium with glossae shorter than paraglossae; glossae with single row of long setae on inner margins, dorsal surface with robust seta near apex, ventral surface with numerous long fine setae and single subapical long robust seta; paraglossae curved medially, truncate apically and with single row of long hair-like setae on outer margin, dorsal surface with numerous long setae and with dense apical patch of fine setae, ventral surface with numerous long fine setae; labial palp 3-segmented, length 0.67–0.82 mm, outer margin of each segment with numerous fine setae, basal segment sub-rectangular 2.31–2.54 times longer than wide, segments II and III combined 1.12–1.26 times longer than basal segment, segment II apically expanded and longer on outer margin than inner margin, dorsal surface with oblique row of fine setae distally, ventral surface with

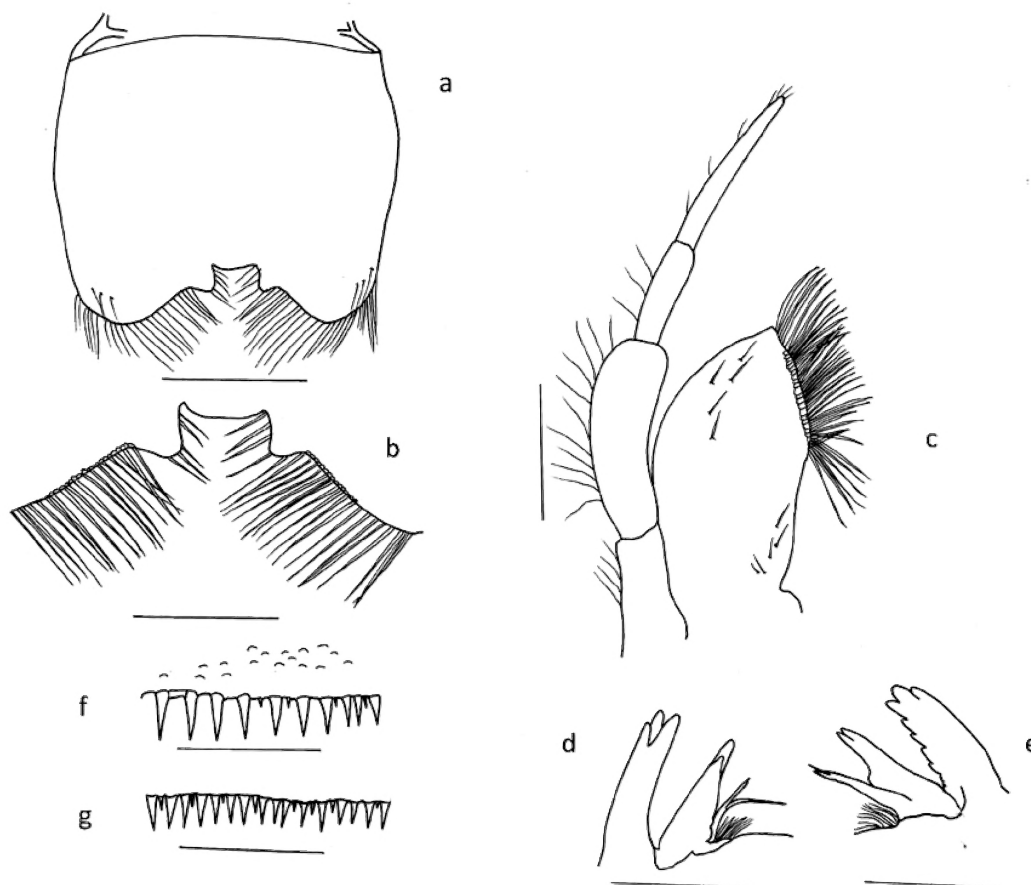


Figure 2. *Skolomystax elongatus*: a, labrum; b, labrum notch; c, maxilla; d, right mandibles incisors; e, left mandible incisors; f, tergite spines; g, sternite spines. Scale lines a, f, g = 0.15 mm, b–e = 0.07 mm.

scattered fine setae; segment III sub-rectangular and slightly falcate, with numerous long robust and short fine setae on margins, dorsal surface with long robust setae distally, ventral surface with scattered fine setae. Segment ratios of labial palp 1.00 (0.34–0.37 mm) : 0.71–1.00 : 0.24–0.35.

**Thorax:** pronotum with dark spots. Mesonotum uniformly coloured. Sterna uniformly coloured.

**Legs:** foreleg 2.05–3.11 mm long with ratios of 1.00 (0.91–1.30 mm) : 0.56–0.67 : 0.58–0.73 : 0.32–0.40 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.53–0.65 times tarsus length. Fore femur 4.10–5.17 times longer than wide at midpoint and with subapical dark band, often separated into two dark spots by longitudinal pale area, and usually with dark band basally; dorsal margin of fore femora with row of 13–24 short sharply pointed robust setae and scattered fine setae and with subapical pair of long, pointed robust setae; anterior surface with 3–4 scattered rows of sharply pointed robust setae just

below dorsal margin, ventral half with numerous sharply pointed robust setae; ventral margin with long fine setae and 4–30 sharply pointed robust setae. Fore tibia slightly darker basally, with 3–17 sharply pointed robust setae and scattered fine setae on outer margin, inner margin with 8–24 long pointed robust setae and long fine setae. Fore tarsus slightly darker basally, with 0–8 sharply pointed robust setae, scattered long fine setae and apical patch of long fine setae on outer margin, inner margin with single distinct row of 19–23 long sharply pointed setae, some of robust setae may be slightly fimbriate distally. Tarsal claw with two similar rows of denticles in basal half. Middle leg 2.81–3.01 mm long, with subapical dark band on femora not divided, segment ratios 1.00 (1.07–1.38 mm) : 0.55–0.64 : 0.53–0.73 : 0.34–0.41, tarsal claw 0.50–0.71 times tarsus length; femur 4.50–6.11 times longer than wide. Mid-femur with 20–36 sharply pointed robust setae on outer margin, inner margin with 6–34 sharp setae; mid-tibia with 3–17 sharply pointed robust setae on outer margin and 8–22 short sharply pointed robust setae on



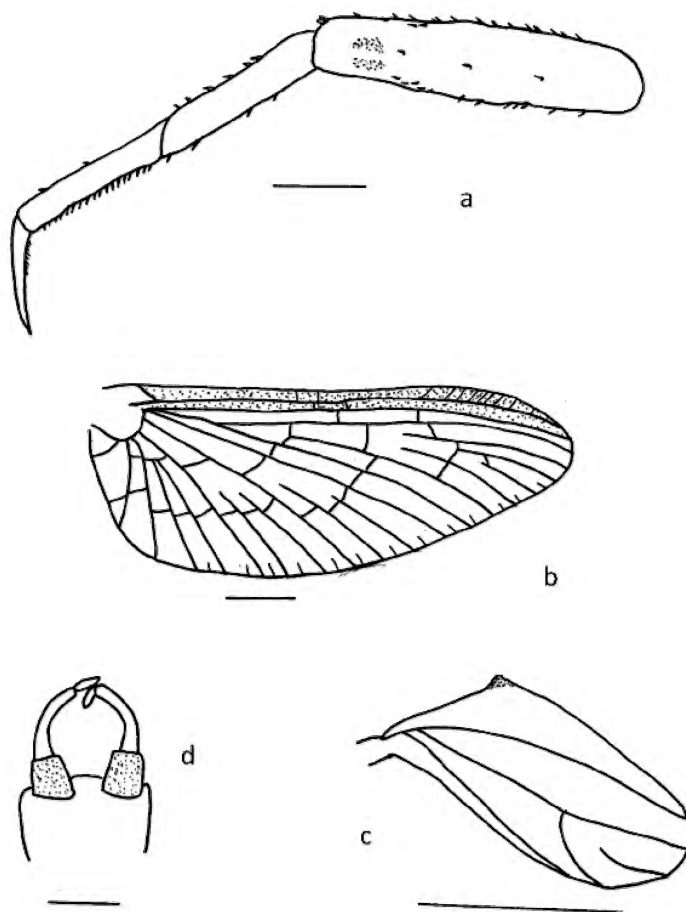


Figure 3. *Skolomystax elongatus*: a, leg of nymph; b, forewing of male imago; c, enlarged hind wing of male imago; d, genitalia of male imago. Scale lines = 1 mm.

inner margin; mid-tarsus with 0–5 sharply pointed robust setae on outer margin and 19–31 short sharply pointed robust setae on inner margin; tarsal claw with two similar rows of denticles in basal half. Hind leg 2.29–3.02 mm long, with subapical dark band on femora not divided, segment ratios 1.00 (1.11–1.47 mm): 0.55–0.64 : 0.52–0.60 : 0.31–0.39, tarsal claw 0.59–0.71 times tarsus length; femur 4.62–7.22 times longer than wide. Hind femur with 18–38 sharp sharply pointed robust setae on outer margin and 0–29 sharply pointed robust setae on inner margin; hind tibia with 4–20 sharply pointed robust setae on outer margin and 8–25 on inner margin; hind tarsus with 0–6 sharply pointed robust setae on outer margin and 19–24 sharply pointed robust setae on inner margin, tarsal claw with two similar rows of denticles in basal half.

**Abdomen:** abdominal tergites with dark lateral spots on segments III–VII, segments I–III, V–VII and IX dark with other segments light with few dark spots (Suter, 1986: 388, fig. 23f; fig. 25a).

Abdominal terga I–X with numerous alternating long and short spines on posterior margins, long spines 2.70–4.63 times longer than basal width, separated by greater than spine width (fig. 2f). Gills I and II somewhat cordate and pointed, gills III–VII apically rounded. Sterna III–IX with long narrow spines on posterior margin with short spines between, base of spines contiguous, long spines 2.17–3.89 times longer than width (fig. 2g). Paraprocts with 17–25 marginal spines, surface with scattered long fine setae and scale bases; slight gap between main and lateral parts; lateral part of paraproct with small spines. Cerci and terminal filament subequal in size, slightly darkened distally, every other articulation darkly coloured, and inner surfaces with long fine setae nearly to apex.

**Male imago:** fully described by Suter (1986) and characteristics are given in generic diagnosis. Wings and forceps are illustrated in fig. 3.

## Distribution

Widespread in southeastern Australia, including SA, Vic and NSW.

## Discussion

The presence of robust setae on the outer margins of the tibiae differentiates *S. elongatus* from all other known species except *S. brevis* and *S. paschei*. *Skolomystax elongatus* is larger (body length >8 mm) than both *S. brevis* (<6.5 mm) and *S. paschei* (6.7 mm). *Skolomystax elongatus* is most easily differentiated from *S. brevis* by the absence of dark markings on mandibles, genae and labrum, the alternating long and short spines on the posterior margins of the terga and sterna (versus equal-sized) and the presence of at least five teeth on the inner margin of the left outer incisors of the mandibles (versus three). Additional discriminating characters are detailed in Table 2.

*Skolomystax elongatus* differs from *S. paschei* in being larger (see above); having <25 setae on the inner margin of the hind tarsus (versus >30); maxillary palp segment II distinctly shorter than segment I (versus subequal); basally separated tergal spines (versus contiguous); labrum with narrow notch angle of approximately 100° versus approximately 130°; length of labial palp segment II+III <1.3 x longer than basal length and >1.7 x longer for *S. paschei*.

A unique colour morph with a median longitudinal dark stripe on the abdomen and a pair of submedian dark stripes on the mesonotum (fig. 251) has been encountered and was previously treated as distinct species (Webb and Suter, 2011). Based on COI sequences, however, it appears conspecific with *S. elongatus* (specimen 110357 on fig. 1).

## *Skolomystax brevis* n. sp. (figs. 4, 5, 25b)

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## *Centroptilum* spLogan in Webb and Suter (2011)

**Material examined.** *Holotype*: nymph mounted on slides. Qld: Logan River at Mt. Barney Lodge, JWA394, 28.28S 152.74E, 2 Dec 2007, JW, DB, ANIC6-000083.

**Paratypes**: nymphs, three mounted on slides. Qld: Coochin Ck at Bruce Hwy, JWA1401, Monitoring River Health (MRH) #1410007, 26.86S 153.02E, 4 Nov 1994, ANIC 6-000084. NSW: Cedar Brush Ck on Cedar Brush Rd, JWA1281, 33.15S 151.26E, 10 Mar 2009, JW, JHH, ANIC 6-000085; Cedar Brush Ck on Cedar Brush Rd, JWA1303, 33.15S 151.26E, 10 Mar 2009, JW, JHH, ANIC 6-000086; Location: Site 27. Bellinger River, 23.7km u/s of Thora, JWA1394, 30.46S 152.58E, 29 Nov 1998, PS, JD, 1 specimen in alcohol, ANIC 6-000087.

**Other material examined.** *Mature nymph*. Qld: Coochin Ck at Bruce Hwy, JWA1407, JWA1408, 26.86S 153.02E.

*Adults*: Unknown.

## Nymph – description

**Body**: 5.3–6.5 mm.

**Head**: light with distinct brown markings, particularly on the genae, at the base of mandibles and anterior margin of the

fronto-clypeus (fig. 5d). Antennae with scape 1.24 times length of pedicel.

**Mouthparts**: labrum (fig. 4a) 0.76–1.36 times wider than long; labrum notch depth 0.74–0.81 times labrum length, notch depth 0.29–0.32 times width (fig. 4b); notch deep, angled with large lateral projections, notch angle approximately 105°, lined with 19–25 fimbriate setae on each side, ventrally with numerous fimbriate setae apically, numerous scattered fine setae, apical corners with 12–17 long and robust setae and laterally with submarginal scattered row of seven short robust setae. Mandibles with distinct black/brown spot at base (figs. 4e, 4f, 5d). Right mandible (planate) (figs. 4e, g) with three apical teeth and lacking lateral spine on inner margin of outer incisor (fig. 4g); inner incisor with broad surface and with three indistinct apical teeth; prosthema slender with a long setule at midpoint, setule fringed at apex, patch of fine setae at base (fig. 4g). Left mandible (angulate) (figs. 4f, h) with three apical teeth and three inner teeth on inner margin of outer incisor (fig. 4h); inner incisor with three apical teeth, inner margin expanded and smooth; prosthema robust and simple with several long spines on comb, and with patch of setae at base (fig. 4h). Maxillae (fig. 4c) with 4–6 subcrest setae on ventral surface, 2–3 hump setae, and >20 lacinial setae, lateral margin below palp lacking setae; maxillary palp 3-segmented, total length 0.34–0.35 mm, palp extends well beyond apex of galealacinia, segment I and II combined extend beyond apex of galealacinia, all segments with sparse very fine hair-like setae on outer margins (difficult to see), segment I somewhat curved and not reaching apex of galealacinia, with approximately 20 small tubercles; length of palp segments II and III combined 1.40–1.56 times length of basal segment, segment III length 1.22–1.73 times length of segment II; segment ratios of 1.00 (0.18–0.19 mm) : 0.57–0.68 : 0.79–0.99. Hypopharynx (fig. 4d). Labium (figs. 5a, b) with glossae slightly shorter than paraglossae; glossae with 11–12 setae on outer margins, inner with 12–14 fine setae (fig. 5b), inner margins lined with numerous long setae (figs. 5a, b); paraglossae curved medially, truncate apically and with numerous long fine hair-like setae on outer margin and three rows of 10–18 long setae ventrally (fig. 5b) and 3–4 rows dorsally (fig. 5a); labial palp 3-segmented (figs. 5a, b), palp length 0.52–0.55 mm, outer margin of each segment lacking setae; length of segment II and III combined 1.14–1.65 times length of basal segment, segment ratios 1.00 (0.20–0.25 mm) : 0.90–1.37 : 0.21–0.28, segment I sub-rectangular 1.89–2.64 times longer than wide, segment II apically expanded and longer on outer margin than inner margin, dorsal surface with few setae; segment III subrectangular and slightly falcate with 10–12 long robust setae on apical margins, dorsal surface with 6–7 long robust setae distally.

**Legs**: foreleg (fig. 5c) total length of 1.68–1.85 mm, segment ratios of 1.0 (0.73–0.82 mm) : 0.58–0.68 : 0.61–0.69 : 0.38) (femur : tibia : tarsus : claw). Fore femur 4.31–5.66 times longer than wide with subapical dark band, and usually slightly darker basally; outer margin of fore femora with 8–26 short sharply pointed robust setae, with subapical pair of long, pointed robust setae; inner margin with 5–11 short sharply pointed robust setae. Fore tibia slightly darker basally and apically, outer margin with 5–8 short sharp setae, inner margins with 9–12 long sharp setae. Fore tarsus without darker markings, with outer margin with 1–2

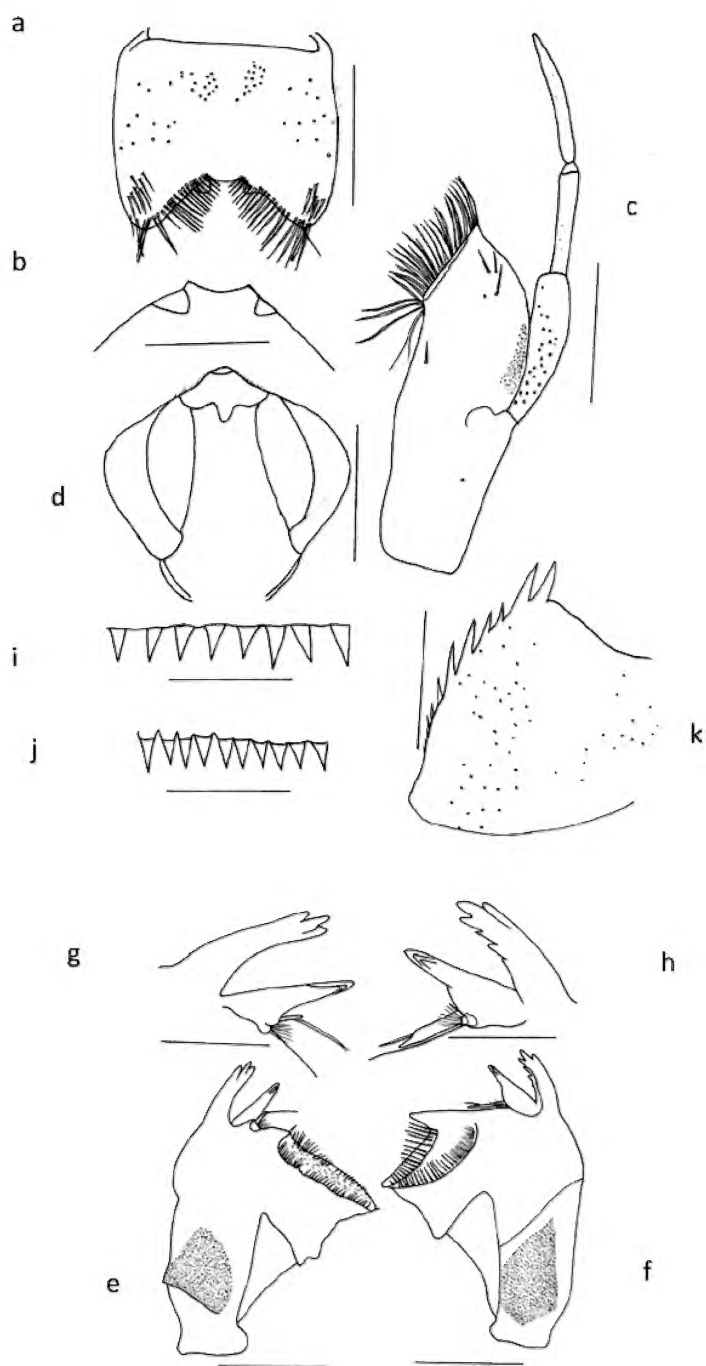


Figure 4. *Skolomystax brevis*: a, labrum; b, labrum notch; c, maxilla; d, hypopharynx; e, right mandible; f, left mandible; g, right mandible incisors; h, left mandible incisors; i, tergite spines; j, sternite spines; k, paraproct. Scale lines: a, c-f, i-k = 0.15 mm; b, g, h = 0.07 mm.

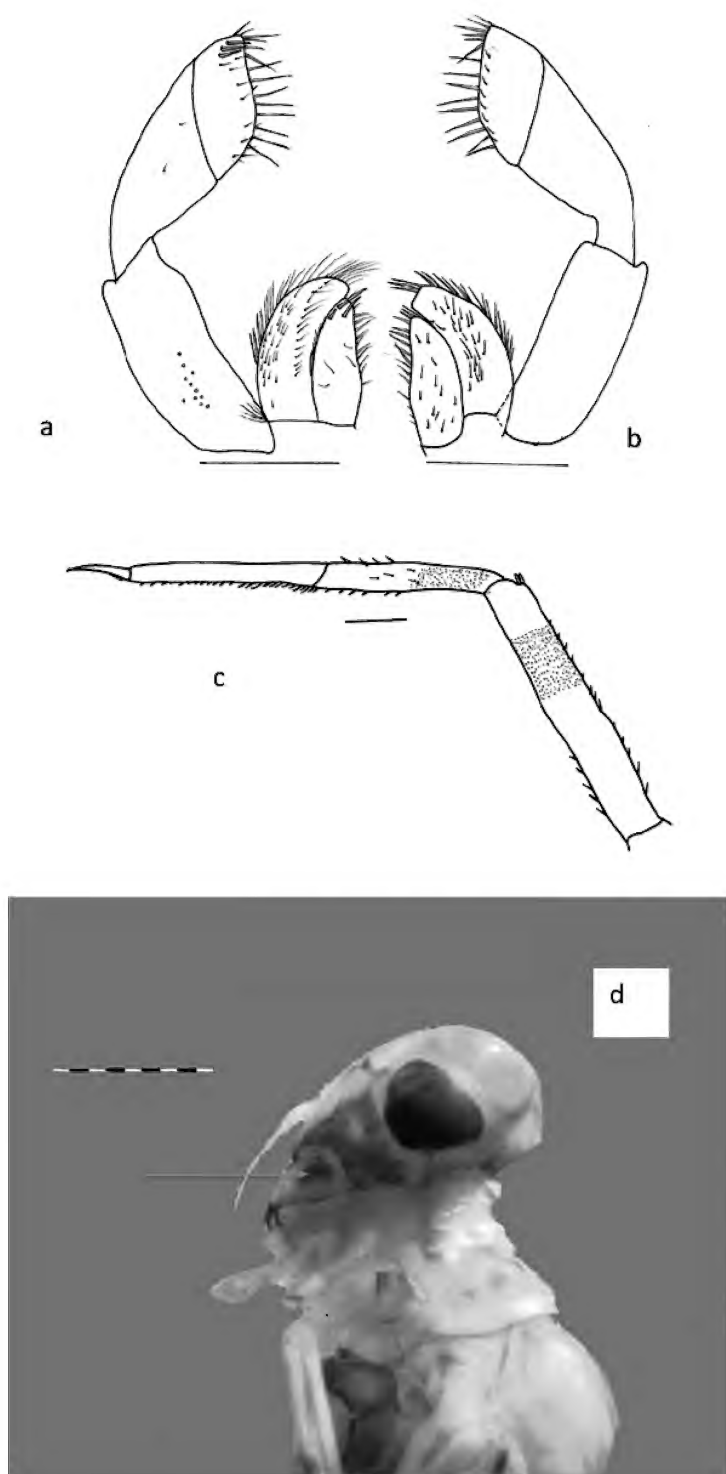


Figure 5. *Skolomystax brevis*: a, labium dorsal; b, labium ventral; c, leg; d, lateral of head showing dark markings and mandibular marking arrowed. Scale lines a, b = 0.15 mm, c, d = 1 mm.

short sharp robust setae, inner margin with 18–30 long sharp setae some of robust setae may be slightly fimbriate distally. Tarsal claw 0.55–0.56 times length of tarsus, with two similar rows of denticles in basal half. Middle leg total length of 1.99–2.06 with segment ratios of 1.00 (0.92–0.97 mm) : 0.59 : 0.55 : 0.25–0.37. Mid-femur 6.48–6.53 times longer than wide with subapical dark band, and slightly darker basally; outer margin of mid-femora with 16–26 short sharply pointed robust setae and with subapical pair of long, pointed robust setae; inner margin with 5–10 short sharply pointed robust setae. Mid-tibia slightly darker basally, outer margin 4–6 sharp setae, inner margins with 9–13 long sharp setae. Mid-tarsus without markings, with outer margin with 2–4 sharp pointed robust setae, inner margin with 13–20 long sharp setae; some robust setae may be slightly fimbriate distally. Tarsal claw 0.46–0.67 times length of tarsus, with two similar rows of denticles in basal half. Hind leg total length 1.90–2.36 mm, with segment ratios of 1.00 (0.99–1.19 mm) : 0.52–0.61 : 0.46–0.56 : 0.29–0.40. Hind femur 6.40–6.71 times longer than wide with subapical dark marking and slightly darker basally; outer margin of hind femora with 20–23 short sharply pointed robust setae and scattered fine setae and with subapical pair of long, pointed robust setae; inner margin with 2–9 short sharply pointed robust setae. Hind tibia slightly darker basally, outer margin 4–8 sharp setae, inner margins with 9–16 long sharp setae. Hind tarsus without dark markings, with outer margin with 0–2 short sharp robust setae, inner margin with 9–17 long sharp setae; some robust setae may be slightly fimbriate distally. Tarsal claw 0.64–0.71 times length of tarsus, with two similar rows of denticles in basal half.

**Abdomen:** abdominal tergites with a distinct colour pattern (fig. 25b), dark lateral marks on segment II–VII, light IV, dark saddle on V and VI, light VII and VIII and dark IX; segment VI with central posterior light spot and darker C-shaped marking anterior to light spot, segment VII with dark marking medial to centre. Posterior margin of abdominal terga with long and widely spaced spines of equal size (fig. 4i), length (0.03 mm) 1.88–2.64 times width. Sterna V–IX with conical spines on posterior margin with bases contiguous (fig. 4j), spine length (0.03 mm) 1.86–2.25 times width. Paraprocts (fig. 4k) with 12–17 marginal spines, surface with scattered scale bases.

## Discussion

Webb and Suter (2011) included this species in a key under the informal name of *Centropilum* spLogan. The presence of robust setae on the outer margins of the tibiae and tarsi differentiates *S. brevis* from all other known species except *S. elongatus* and *S. paschei*. It can be differentiated from both of those species by having black “cheeks” (the base of the mandibles, genae and labrum fig. 5d) and by having all the spines of the posterior margins of the abdominal terga subequal in size and distinctly separated basally (fig. 4i). Additionally, *S. brevis* is smaller than *S. elongatus* and has many fewer robust setae on the legs than *S. paschei*.

**Etymology:** the specific epithet *brevis* is an adjective and refers to the small size relative to other species, which have robust setae on the outer margin of the tibiae.

**Distribution:** eastern NSW north of Sydney, southeast Qld.

## *Skolomystax chionotos* n. sp. (figs. 6, 7, 25c)

urn:lsid:zoobank.org:act:C28AF825-92EE-475E-A91F-ED44C4AF1296

## *Centropilum* spSnowy in Webb and Suter (2011).

**Material examined.** *Holotype:* nymph mounted on slides. Vic: Snowy Ck on Omeo Highway near Mitta Mitta, JWA753, 36.545S 147.384E, 3 Sept 2007, JW, ANIC6–000104.

*Paratype:* one nymph mounted on slides. Vic: Snowy Ck on Omeo Highway near Mitta Mitta, JWA353, 36.55S 147.38E, 9 Mar 2007, JW, ANIC6–000105.

## Nymph – description

**Body:** 8.0–10.0 mm; terminal filament 0.96 times cerci length.

**Head:** antennae with scape 1.35 times length of pedicel.

**Mouthparts:** labrum (fig. 6a) 1.14–1.22 times wider than long, notch depth 0.34–0.36 times notch width (fig. 6b), depth 0.72–0.74 times labrum length, notch angle 95°, notch with 26 setae on each side, five setae laterally. Right mandible (planate) (figs. 6d, f) with three apical teeth and no lateral spines on inner margin of outer incisor; inner incisor with broad surface and with 2–3 indistinct teeth incisor, inner margin smooth; prosthema slender and forked with patch of fine setae at base (fig. 6f); dorsal surface lacking fine setae or scales. Left mandible (angulate) (figs. 6e, g) with three apical teeth and 4–5 inner teeth on outer incisor; inner incisor with three apical teeth and no inner teeth on expanded base, slightly rugose (fig. 6g); prosthema robust, simple, with patch of setae at base (fig. 6g); dorsal surface without scattered fine setae or scales. Maxillae (fig. 6c) with two subcrest setae on ventral surface, 5–7 hump setae, and 20–26 lacinial setae; maxillary palp 3-segmented, 0.27–0.37 mm long, extending well beyond apex of galea-lacinia; segment I somewhat curved, reaching apical third of galealacinia, with rare long fine hair-like setae on outer margin; segments I and II combined extend beyond galealacinia, segments II and III together 1.12 times longer than segment I; segment II with rare long fine hair-like setae, 1.33 times segment III length; segment III with rare long fine hair-like setae; segment ratios of 1.00 (0.25–0.27 mm) : 0.64 : 0.48. Hypopharynx as for *S. elongatus*. Labium (figs. 7a, b) with glossae slightly shorter than paraglossae; glossae with 15 long setae on outer margin, inner margin with 13 setae, ventral surface with numerous long fine setae (fig. 7b), dorsal surface with two rows of setae (fig. 7a); paraglossae curved medially, truncate apically and with single row of 37 long setae on outer margin, ventral surface with multiple rows of long setae, dorsal surface with patch of setae (fig. 7a); palp 3-segmented, 0.79–0.80 mm long, segment ratios 1.00 (0.36–0.37 mm) : 0.97–1.03 : 0.18–0.19, segments II and III combined 1.16–1.20 times basal segment length; segment I lacking setae on inner and outer margins, length 2.64–3.52 times width, segment II apically expanded and longer on outer margin than inner margin, ventral surface with scattered fine setae; segment III sub-rectangular and slightly falcate, with 7–16 long robust setae on terminal margins, dorsal surface with robust setae distally, ventral surface with scattered fine setae.

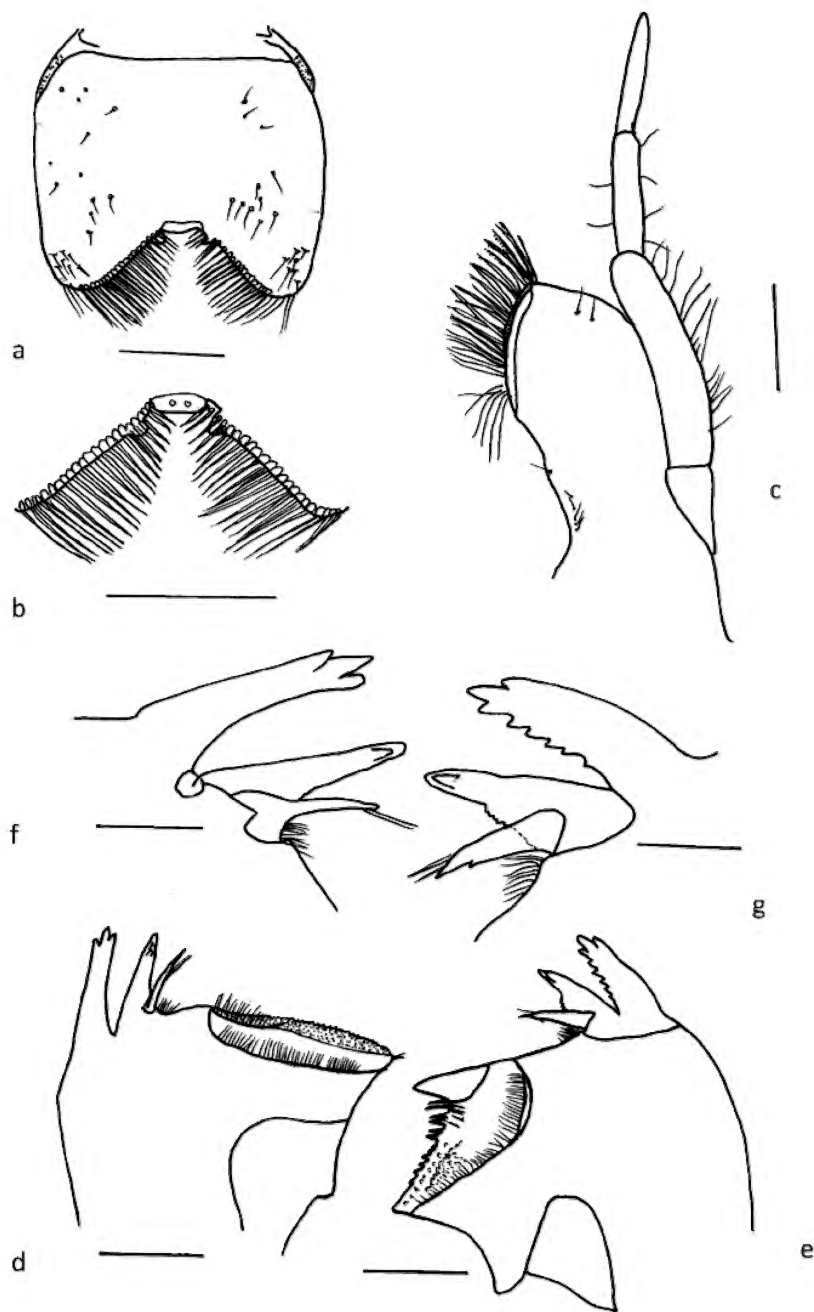


Figure 6. *Skolomystax chionotos*: a, labrum; b, labrum notch; c, maxilla; d, right mandible; e, left mandible; f, right mandible incisors; g, left mandible incisors; Scale lines: a, c–e = 0.15 mm; b, f, g = 0.07 mm.

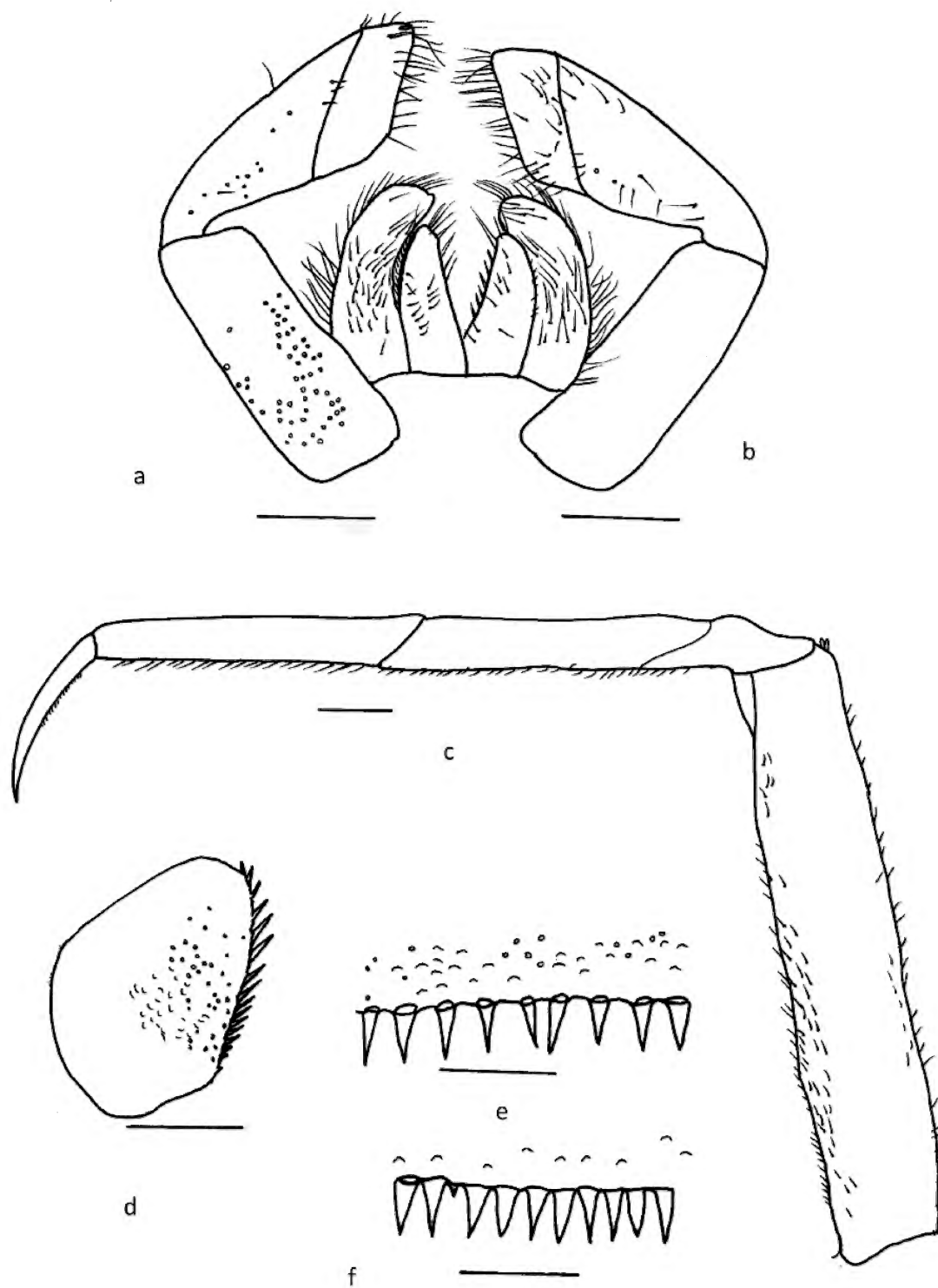


Figure 7. *Skolomystax chionotos*: a, labium dorsal; b, labium ventral; c, leg; d, paraproct; e, tergite spines; f, sternite spines. Scale lines: a–f = 0.15 mm.

**Thorax:** pronotum without any distinct spots. Mesonotum light with darker medial markings. Sterna uniformly coloured.

**Legs:** legs with indistinct markings in specimens examined (fig. 7c). Foreleg 2.62 mm long, segment ratios of 1.00 (1.27 mm) : 0.55 : 0.51 : 0.31. Fore femur 6.35 times longer than wide. Fore femur with dorsal margin of fore femora with row of 23 long sharply pointed robust setae and scattered short setae, with subapical pair of short, blunt setae; ventral margin with 34 long pointed robust setae. Fore tibia slightly darker basally, without setae on outer margin, inner margin with 13 long robust setae. Fore tarsus slightly darker basally, without setae on outer margin, inner margin with 12 long pointed setae. Tarsal claw length 0.61 times tarsal length with two similar rows of denticles in basal half. Mid-leg 3.10 mm long, segment ratios of 1.00 (1.50 mm) : 0.60 : 0.47 : 0.33. Mid-femur 6.00 times longer than wide. Mid-femur with dorsal margin of mid-femora with row of 37 long sharply pointed robust setae and scattered short setae, and subapical pair of short, blunt setae; ventral margin with 26 long pointed robust setae. Mid-tibia slightly darker basally, without setae on outer margin, inner margin with 24 long robust setae; mid-tarsus slightly darker basally, without setae on outer margin, inner margin with 25 long pointed setae. Tarsal claw length 0.71 times tarsus length with two similar rows of denticles in basal half. Hind leg 2.69–3.00 mm long, segment ratios of 1.00 (1.20–1.50 mm) : 0.60–0.62 : 0.40–0.61 : 0.30–0.34 (femur: tibia: tarsus: claw measured on outer margin). Hind femur 5.03–6.00 times longer than wide. Femora with dorsal margin of femora with row of 27–39 long sharply pointed robust setae and scattered short setae and with subapical pair of short, blunt setae; ventral margin with 24–30 long sharp robust setae. Hind tibia slightly darker basally, without setae on outer margin, inner margin with 22–31 long robust setae. Hind tarsus slightly darker basally, without setae on outer margin, inner margin with 24–27 long pointed setae. Tarsal claw length 0.55–0.75 times tarsal length with two similar rows of denticles in basal half.

**Abdomen:** abdominal tergites with a distinct colour pattern (fig. 25c), segments I dark medially and laterally with light patches, segment II and III light darker anteriorly with medial and lateral dark markings, segment IV light, segments V dark, light VI–VIII light with antero-medial elongate spot and lateral dark patches, segments IX and X dark both with antero-medial dark elongate spot. Abdominal terga with numerous long spines on posterior margins (fig. 7e), spine length 1.93–2.45 times basal width, bases of spines separated by width of spine. Surfaces of terga with pointed scales and scale bases. Gills I and II somewhat cordate and pointed. Sterna IV–IX with spines on posterior margin (fig. 7f), spine length 2.34–2.67 times basal width, bases contiguous. Surfaces of sterna with scale bases. Paraprocts (fig. 7d) with 19–21 marginal spines, surface with scale bases. Cerci and terminal filament subequal in size inner surfaces with long fine setae nearly to apex.

**Adults:** unknown.

**Etymology:** a noun in apposition formed from the Greek words *chioni* (snow) and *notos* (south), in reference to the type locality, Snowy Creek.

**Distribution:** Vic.

## Discussion

The absence of setae on the outer margins of the tibiae and tarsi differentiates *S. chionotos* from *S. elongatus*, *S. brevis* and *S. paschei*. All other *Skolomystax* lack setae on the tibiae and tarsi, but *S. chionotos* can be differentiated from *S. hawkingi* and *S. leichhardti* by the absence of fine black spotting on the abdomen, by having 4–5 teeth on the inner margin of the outer incisor of the left mandible vs. 1–3 teeth, and by its more southern distribution. *Skolomystax chionotos* differs from *S. dyarri* and *S. gippslandicus* in having spines on the posterior margins of abdominal sterna IV–IX, vs. VI–IX or VII–IX, and from *S. goorudensis* by having only long spines on the posterior margins of the abdominal terga, instead of alternating long and short spines. The remaining species, *S. tasmaniensis* and *S. vulgaris*, are difficult to distinguish from *S. chionotos*, but they have maxillary palp segment II short than or equal in length to segment III, whereas maxillary palp segment II is longer than segment II in *S. chionotos*.

## *Skolomystax dyarri* n. sp. (figs. 8, 9, 25d)

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## *Centropilum* sp6 in Webb and Suter (2011).

**Material examined.** *Holotype:* nymph mounted on slides. NSW: Cedar Brush Ck, JWA1304, 33.15S 151.26E, 10 Mar 2009, JW, JHH, ANIC6–000100.

*Paratype:* one nymph mounted on slides. NSW: McCarrs Ck, JWA1983, 33.66S 151.25E, 11 May 2009, SWC, ANIC6–000101.

## Nymph – description

**Body:** 5.95–7.5 mm.

**Head:** light medial band edged by two dark linear markings lateral to eyes. Antennae with scape 1.30–1.65 times length of pedicel.

**Mouthparts:** labrum (fig. 8a) 1.27–1.36 times slightly wider than long, labrum notch wide, depth 0.24–0.30 times notch width (fig. 8b), labrum notch depth 0.73–0.76 times labrum length, notch angle approximately 117°, notch lined with >30 setae, ventrally with ten fimbriate setae apically, numerous scattered fine setae, those at apical corners distinctly longer and more robust, and laterally with submarginal row of 7–10 short robust setae; dorsally with numerous scattered long fine hair-like setae. Right mandible (planate) (figs. 8d, f) with three apical teeth on outer incisor, lacking lateral spine on inner margin of outer incisor; inner incisor with broad surface and with three indistinct teeth, no lateral teeth; prostheca slender with bifid setae near apex, patch of fine setae at base (fig. 8f); dorsal surface without scattered fine setae or scales. Left mandible (angulate) (figs. 8e, g) three apical teeth and four teeth on the inner margin of outer incisor (fig. 8g); inner incisor with three apical teeth, inner margin expanded near base; prostheca robust, setae near apex, sparse patch of setae at base (fig. 8g); dorsal surface lacking



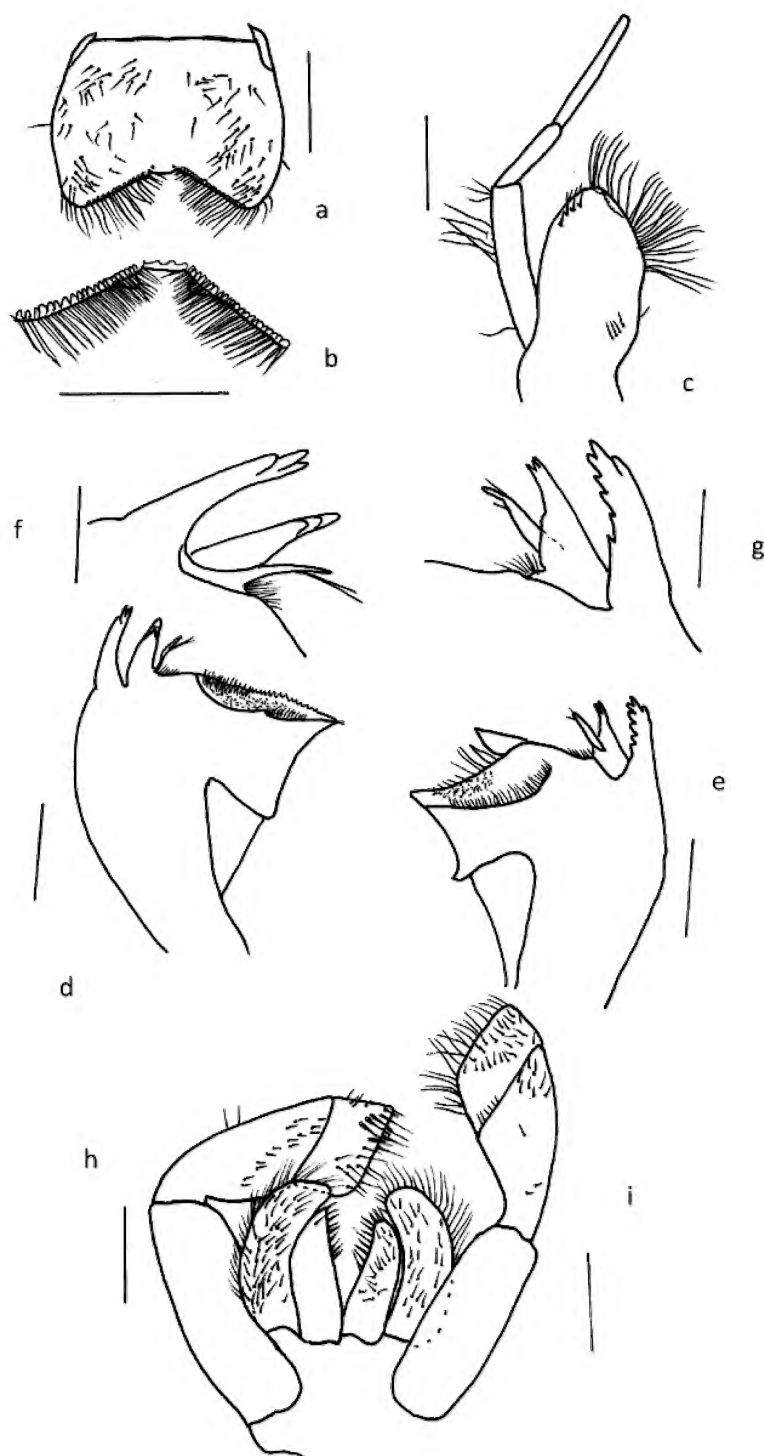


Figure 8. *Skolomystax dyarrii*: a, labrum; b, labrum notch; c, maxilla; d, right mandible; e, left mandible; f, right mandible incisors; g, left mandible incisors; h, labium dorsal; i, labium ventral. Scale lines: a, c-e, h, i = 0.15 mm; b, f, g = 0.07 mm.

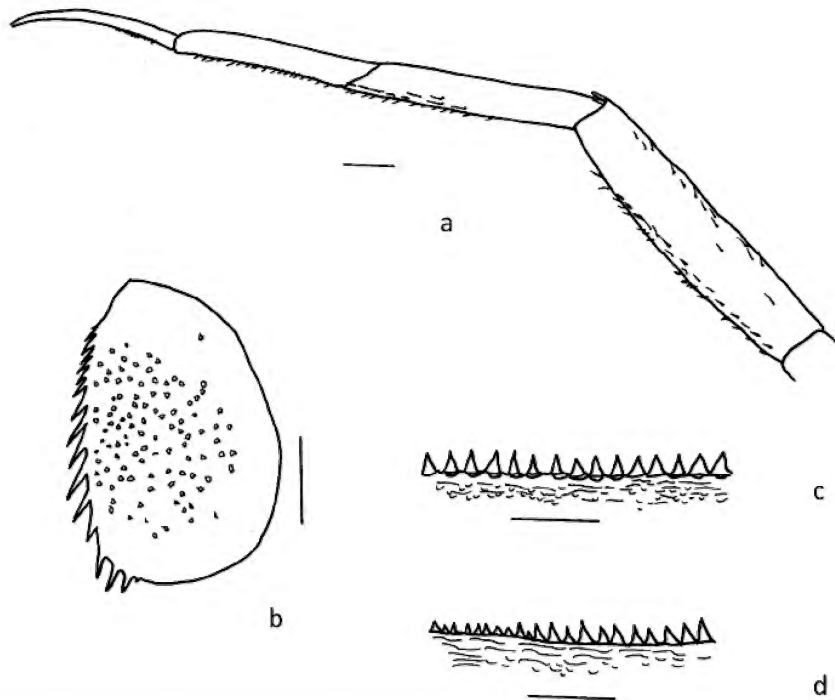


Figure 9. *Skolomystax dyarri*: a, leg; b, paraproct; c, tergite spines; d, sternite spines. Scale lines: a–d = 0.15 mm.

scattered fine setae and scales. Maxillae (fig. 8c) with apical 2–3 long broad spines apically and 37–38 lacinial setae, with 2–5 subcrest setae on ventral surface, 4–5 hump setae, lateral margin below palp lacking fine setae; maxillary palp 3-segmented, 0.24–0.37 mm long, palp long extending well beyond the galealacinia, segment I extends nearly to apex of galealacinia, segments I+II combined reaching well beyond apex of galealacinia; segment ratios 1.00 (0.20–0.24 mm) : 0.54 : 0.83; segment II and III combined 1.37 times basal segment length, segment III 1.55 times segment II length; palp segment I slightly curved with long fine hair-like setae on outer margin, segment II with rare long fine setae; segment 3 with rare long fine setae. Hypopharynx as for *S. elongatus*. Labium (figs. 8h, i) with glossae slightly shorter than paraglossae; glossae with 12 outer setae, 9–11 inner setae and 3–6 apically, ventral surface with numerous long fine setae (fig. 8i); paraglossae curved medially, truncate apically with single row of >20 fine setae on outer margin, ventral surface with four rows of numerous long fine setae; labial palp 3-segmented, length 0.65 mm, outer margin of each segment without setae, segment I 3.00 times longer than wide, segments II and III combined 1.18 times basal segment length, segment II apically expanded and longer on outer margin than inner margin; segment III subrectangular and slightly falcate with 7–14 long robust and short fine setae on apical margins, dorsal surface with seven long robust setae distally (fig. 8h), ventral surface with scattered fine hair-like setae, segment

ratios (Basal Length (BL)/BL (BL length) : Mid Length (ML)/BL : Apical Length (AL)/BL) 1.00 (0.30 mm) : 0.92 : 0.27.

**Thorax:** pronotum dark. Mesonotum dark medially with postero-lateral light patches; uniformly coloured. Sterna uniformly light coloured.

**Legs:** foreleg length 1.93 mm (not including claw length) with segment ratios of 1.00 (0.86 mm) : 0.63 : 0.63 : 0.47 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.74 times length of tarsus. Fore femur 4.97 times longer than wide without subapical dark marking, dorsal margin of fore femora with row of 16 short sharply pointed robust setae with subapical pair of short, robust setae; anterior surface with 17 setae. Fore tibia with faint basal dark patch and segment shaded, without setae and scattered fine setae on outer margin, inner/posterior surface with 11 sharply pointed setae. Fore tarsus shaded without setae on outer margin and 22 short sharp spine setae on inner margin. Tarsal claw with two similar rows of denticles in basal half. Middle leg (fig. 9a) 2.18–2.75 mm long (not including claw length), segment ratios of 1.00 (1.03–1.50 mm) : 0.56–0.62 : 0.54–0.65 : 0.36–0.41 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.55–0.74 times length of tarsus, femur 6.00–6.24 times longer than wide, dorsal margin of mid-femora with row of 16–20 short sharply pointed robust setae with subapical pair of short, robust setae; ventral margin with 18–21 sharply pointed short setae. Mid-tibia without setae or fine setae

on outer margin, 10–12 setae on inner margin. Mid-tarsus without setae on outer margin and inner margin with single distinct row of 23–29 short sharply pointed setae. Tarsal claw with two similar rows of denticles in basal half. Hind leg length 1.99–2.48 mm, segment ratios of 1.00 (0.87–1.18 mm) : 0.55–0.59 : 0.56–0.57 : 0.34–0.45 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.62–0.80 times length of tarsus, hind femur 5.81–7.34 times longer than wide, dorsal margin of hind femora with row of 14–25 short sharply pointed robust setae with subapical pair of short, robust setae; ventrally with 11–19 sharply pointed short setae. Hind tibia without setae or scattered fine setae on outer margin, with 11–18 setae on inner margin. Hind tarsus without setae on outer margin and inner margin with 20–21 short sharply pointed setae. Tarsal claw with two similar rows of denticles in basal half.

**Abdomen:** abdominal tergites segments II–III with dark Y-shaped marking medially, lighter laterally and dark patch on lateral margins, segment IV light with posterior margin dark, segments V dark with three small light spots on posterior margin, segment VI dark with light markings laterally, segments VII–VIII light with dark patch on posterior-medial margin of segment VIII, segment IX dark with light Y-shaped medial marking, segment X light with antero-medial dark spot (fig. 25d). Abdominal terga I–X with numerous short triangular spines on posterior margins, those on posterior segments 2.05–2.89 times longer than basal width, bases of spines slightly separated (fig. 9c). Surfaces of terga with pointed scales and scale bases. Gills I and II somewhat cordate and pointed, gills III–VII apically rounded. Sternites with triangular spines on posterior margin of segments VI or VII–IX, spines 1.88–2.55 times longer than basal width (fig. 9d), bases of spines nearly contiguous, some spines slightly shorter. Paraprocts (fig. 9b) with 16–19 marginal spines, surface with scale bases.

**Adults:** unknown.

## Discussion

The absence of setae on the outer margins of the tibiae and tarsi differentiates *S. dyarri* from *S. elongatus*, *S. brevis* and *S. paschei*. All other *Skolomystax* lack setae on the tibiae and tarsi, but *S. dyarri* can be differentiated from *S. hawkingi* and *S. leichhardti* by having four teeth on the inner margin of the outer incisor of the left mandible vs. only 1–3 teeth in *S. leichhardti* and one in *S. hawkingi* by the more southern distribution, and by the absence of black spotting on the dorsum. The absence of spines on the posterior margins of sterna anterior to segment VI differentiates *S. dyarri* from *S. goorudensis*, *S. chionotos*, *S. tasmaniensis* and *S. vulgaris*, which have spines beginning on sterna III, IV, and V, respectively. *Skolomystax dyarri* resembles *S. gippslandicus* in most characters, but the inner margin of outer incisor of left mandible has four teeth in *S. dyarri* vs. two in *S. gippslandicus*, and maxillary palp segment II is much shorter than segment III in *S. dyarri*, whereas they are approximately equal in *S. gippslandicus*.

**Etymology:** an adjective from the Sydney aboriginal word *dyarri* meaning short (Troy, 1994), referring to the short second segment of the maxillary palp.

**Distribution:** NSW.

## *Skolomystax gippslandicus* n. sp. (figs. 10, 11, 25e)

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## *Centropitulum* spWonnangatta in Webb and Suter (2011)

**Material examined.** *Holotype:* nymph mounted on slides. Vic: Wonnangatta R on Moroka Junction Track, JWA1731, 37.35S 146.96E, 19 Nov 2008, Vic EPA, ANIC6–000097.

**Paratypes:** two nymphs mounted on slides. NSW: Little George Ck on Kempsey Rd, JWA2884, 30.709S 152.194E, 27 Feb 2011, JM, MS, ANIC6–000098; Little George Ck on Kempsey Rd, JWA2885, 30.7424S 152.1902E, 27 Feb 2011, JM, MS, ANIC6–000099.

**Other material examined.** Vic: Cann River, 37.4988S 149.1543E, Vic EPA, No date. NSW: Little George Ck on Kempsey Rd, JWA2883, 30.709S 152.194E, 27 Feb 2011, JM and MS.

## Nymph – description

**Body:** <8.5 mm.

**Head:** light medially with lateral brown markings beside eyes. Antennae with scape 1.35 times length of pedicel.

**Mouthparts:** labrum 1.15–1.25 times wider than long (fig. 10a); depth of apical notch 0.76–0.77 times labrum length (fig. 10b), notch with pair of projections on inner margin, notch depth 0.26–0.33 times notch width, notch angle approx. 91°, with 23–24 fimbriate setae lining each side of notch, shorter basally, ventrally with numerous scattered fine setae, apical corners with 8–10 long robust setae, submarginal row of four short robust setae. Right mandible (planate) (figs. 10d, f) with three apical teeth and inner margin lacking teeth; inner incisor with broad surface and with 2–3 indistinct teeth, inner margin smooth lacking ornamentation; prosthema slender and forked with long setule extending beyond apex and with dense patch of fine setae at base (fig. 10f); dorsal surface lacking fine setae and scales. Left mandible (angulate) (figs. 10e, g) with three apical teeth and two inner teeth on outer incisor; inner incisor with 2–3 apical teeth, inner margin slightly rugose (fig. 10g); prosthema robust and simple with two short apical spines and a short setule, and with dense patch of setae at base (fig. 10g); dorsal surface lacking scattered fine setae and pointed scales. Maxillae (fig. 10c) with 4–5 subcrest setae on ventral surface, 4–5 hump setae, and 20–26 lacinial setae with three comb setae; maxillary palp 3-segmented, palp length 0.47 mm, segment I extending to apical third of galealacinia; segments II and III together extend well beyond apex of galealacinia; segment I somewhat curved, sparse long fine hair-like setae on outer margin, patch of numerous round tubercles basally; segment II and III with rare long fine hair-like setae, length of these segments combined 1.31 times basal segment length, segment III equal to segment II length; segment ratios 1.00 (0.29 mm): 0.65 : 0.65. Hypopharynx as for *S. elongatus*. Labium (figs. 11a, b) with glossae slightly shorter than paraglossae; glossae with single row of 15–17 long setae on outer margin, 8–13 on inner margin, ventral surface (fig. 11b) with numerous long hair-like setae; dorsal surface (fig. 11a) with 2–3 rows of paraglossae curved medially, truncate apically, ventral surface with sparse setae; dorsal surface with four rows of setae (fig. 11a); labial palp 3-segmented, 0.35–

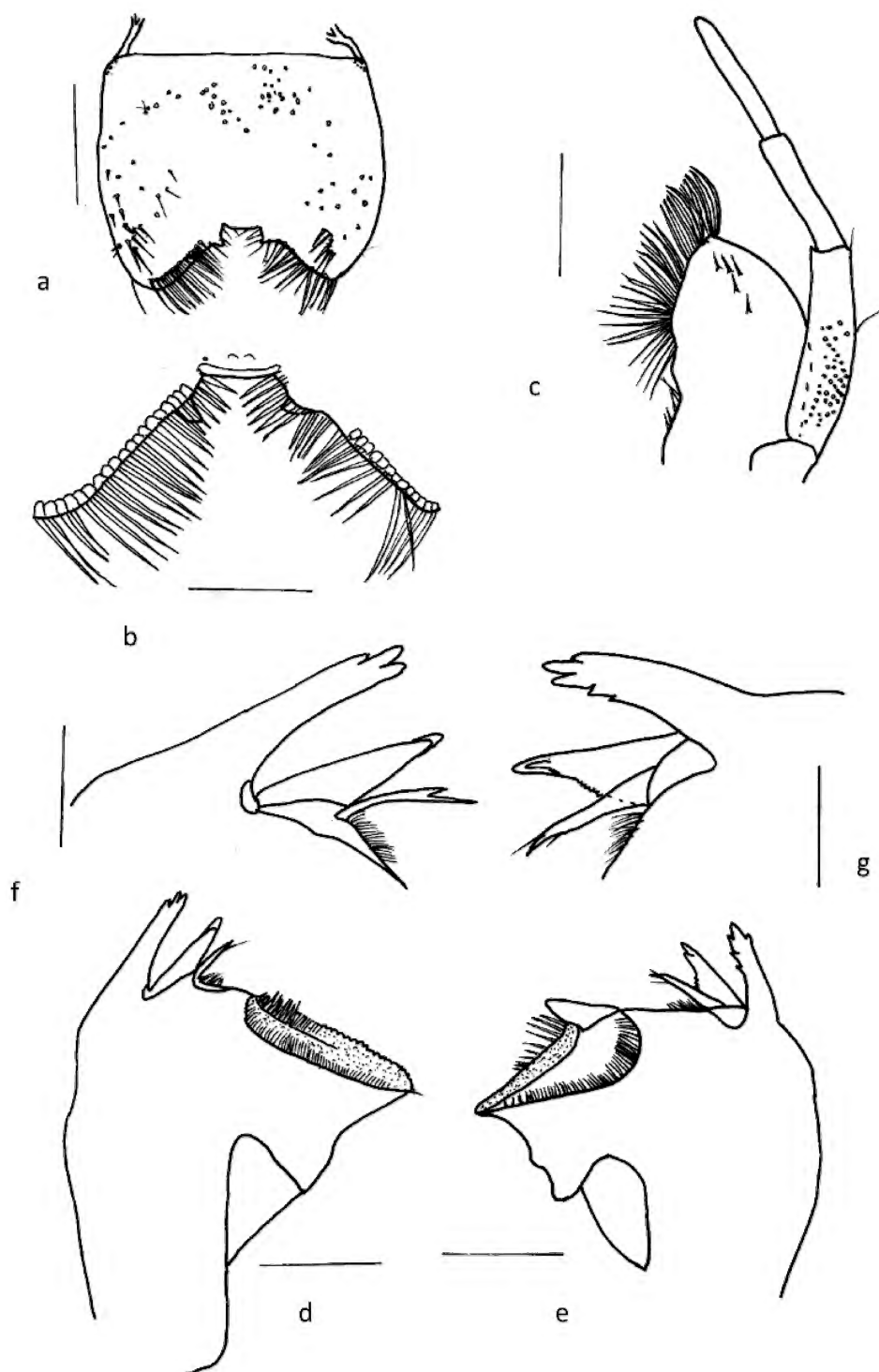


Figure 10. *Skolomystax gippstandicus*: a, labrum; b, labrum notch; c, maxilla; d, right mandible; e, left mandible; f, right mandible incisors; g, left mandible incisors. Scale lines: a, c–e = 0.15 mm; b, f, g = 0.07 mm.

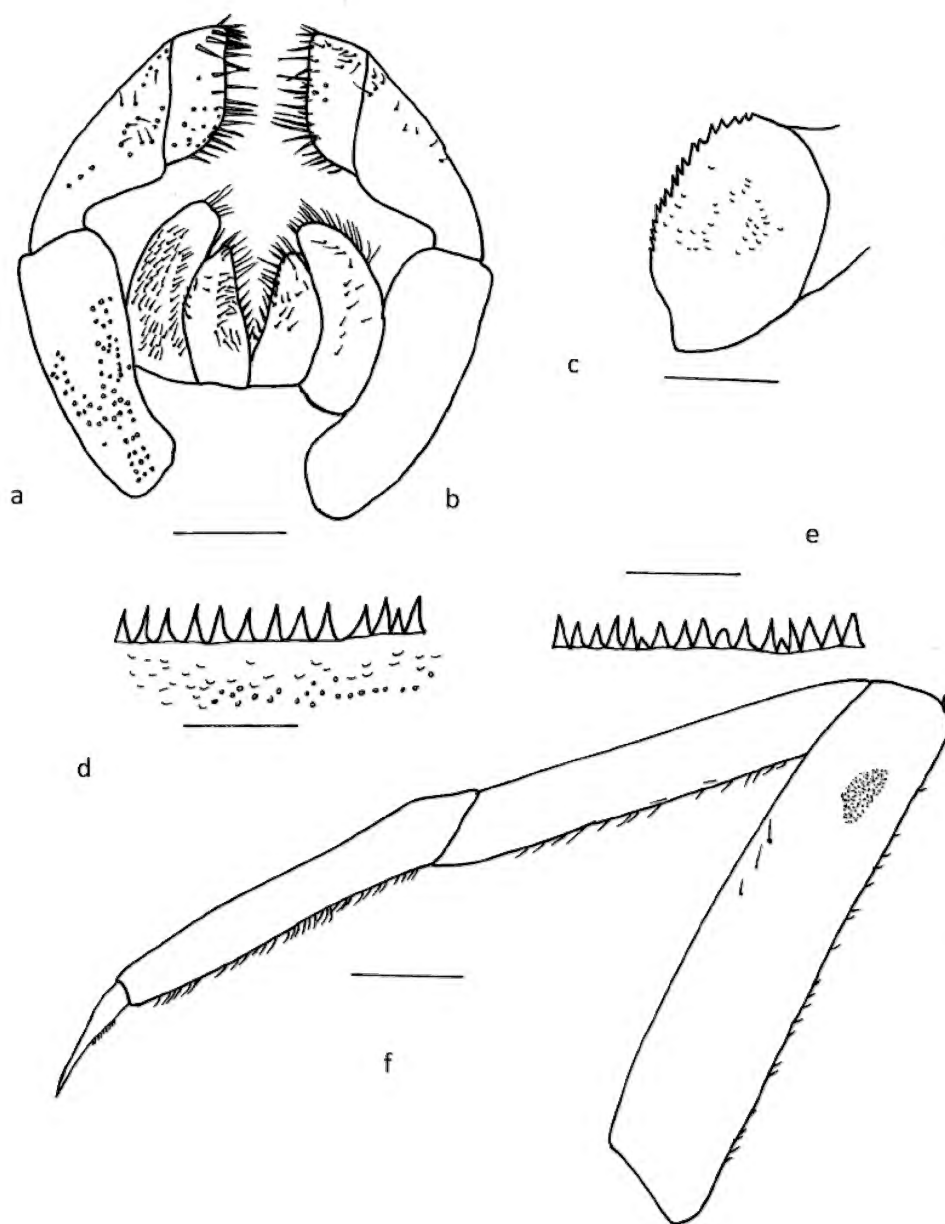


Figure 11. *Skolomystax gippslandicus*: a, labium dorsal; b labium ventral; c, paraproct; d, tergite spines; e, sternite spines; f, leg. Scale lines: a–f = 0.15 mm.

0.69 mm long, outer margin of basal and mid-segments lacking setae, segment ratios 1.00 (0.27–0.35 mm) : 1.25 : 0.28; segment I rectangular 2.08–3.50 times longer than wide, segment II apically expanded and longer on outer margin than inner

margin, segment III subrectangular and slightly falcate apical segment with five setae on outer margin and 14 terminal setae and six dorsal setae; length of segment II and III combined 1.54 times basal segment length.

**Thorax:** pronotum dark medially with lateral light patch containing two dark spots. Mesonotum dark medially with light area anterior to wing pads and dark patch antero-laterally. Sterna uniformly coloured.

**Legs:** foreleg total length 1.80 mm, segment ratios of 1.00 (0.80 mm) : 0.71 : 0.57 : 0.24 (femur : tibia : tarsus : claw measured on outer margin), tarsal claw length 0.43 times tarsus length. Fore femur 4.73 times longer than wide with subapical elongate dark paired markings, outer margin with six short sharp setae, and pair of apical setae, inner margin with 11 short setae. Fore tibia slightly darker basally and apically, outer margin lacking setae, inner margin with 7–9 long spine setae. Fore tarsus without markings, outer margin lacking setae, inner margin with 13–15 long sharp setae. Mid-leg total length 1.77 mm (fig. 11f), segment ratios of 1.00 (0.78 mm) : 0.57 : 0.55 : 0.31 (femur : tibia : tarsus : claw measured on outer margin), mid-tarsal claw length 0.56 times tarsus length. Mid-femur 5.95 times longer than wide with subapical dark marking, which may be paired, outer margin with 12–20 short sharp setae, and pair of broad apical setae, inner margin with 21 short setae. Mid-tibia slightly darker basally and apically, outer margin lacking setae, inner margin with 15–18 long spine setae. Fore tarsus without markings, outer margin lacking setae, inner margin with 25 long sharp setae. Hind leg total length 2.64–3.02 mm, segment ratios of 1.00 (1.29–1.45 mm) : 0.55–0.57 : 0.45–0.49 : 0.26–0.35 (femur : tibia : tarsus : claw measured on outer margin), hind claw length 0.53–0.77 times tarsus length. Hind femur 5.56–7.59 times longer than wide with subapical elongate dark paired marking, outer margin with 25–32 short sharp setae, and pair of apical setae, inner margin with 0–29 short setae. Hind tibia slightly darker basally and apically, outer margin without setae, inner margin with 22–31 long spine setae. Hind tarsus without markings, outer margin lacking setae, inner margin with 24–27 long sharp setae.

**Abdomen:** abdominal tergites with a distinct colour pattern (fig. 26e), segments I dark antero-medially, segments II–IV predominantly light with dark lateral marks and darker posterior margins, segment V dark, segment VI mainly light with a dark anterior line and v-shaped marking medially, segments VII–VIII light with tinged with darker colour with darker anterior marking, segment IX dark with postero-medial light spot, and segment X light with antero-medial dark spot and posterior margin. Abdominal terga with numerous long spines on posterior margins, 3.20–3.40 times longer than basal width (fig. 11d), bases of spines separated by approximately spine width, shorter spines sometimes present. Gills I and II somewhat cordate and pointed, gills III–VII apically rounded. Sterna VI–IX with spines on posterior margin (fig. 11e), spines long, 2.70–3.05 times longer than basal width, bases almost contiguous. Paraprocts (fig. 11c) with 16–24 marginal spines, surface with scattered scale bases.

**Adults:** unknown.

## Discussion

The absence of setae on the outer margins of the tibiae and tarsi differentiates *S. gippslandicus* from *S. elongatus*, *S. brevis* and *S. paschei*. The absence of fine, dark spotting, the thinner maxillary canines and more southern distribution distinguishes

*S. gippslandicus* from *S. hawkingi* and *S. leichhardti*, and the absence of spines on the posterior margins of sterna anterior to segment VI distinguishes it from *S. goorudensis*, *S. chionotos*, *S. tasmaniensis* and *S. vulgaris*. The most similar species is *S. dyarrii*, but *S. gippslandicus* possesses an elongate dark spot sub-apically on the femora, two teeth on the inner margin of outer incisor of the left mandible rather than four. Additionally, the lengths of maxillary palp segments II and III are subequal, but in *S. dyarrii* segment II is much shorter than III.

**Etymology:** named from the region (Gippsland, Vic), where this species was first recorded.

**Distribution:** Gippsland, Vic and southern NSW.

## *Skolomystax goorudensis* n. sp. (figs. 12, 13, 25f)

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**Material examined.** *Holotype:* nymph mounted on slides. **NSW:** Goorudee Rivulet in Upper Murrumbidgee R north of Adaminyab, JWA257, 35.98S 148.77E, 11 Mar 2000, PS, ANIC6–000102.

*Paratype:* one nymph mounted on slides. Hacking R at McKells Ave, JWA2494, 34.15S 151.03E, 15 Sept 2009, SWC, ANIC6–0001103.

## Nymph – description

**Body:** 6.6–7.4 mm.

**Head:** antennae with scape 1.16–1.39 times length of pedicel.

**Mouthparts:** labrum 1.07–1.16 times wider than long (fig. 12a), margins curved, convex; notch deep and broad (fig. 12b), depth 0.35–0.46 width, notch depth 0.66–0.73 times labrum length, notch angle approx. 93°, notch lined with 27–29 setae; ventrally with 10–12 fimbriate setae apically, numerous scattered fine setae; dorsally with numerous scattered long fine hair-like setae. Right mandible (planate) (figs. 12d, f) with three apical teeth on outer incisor; inner incisor with broad surface and with three indistinct teeth, inner margin smooth without lateral teeth; prosthema slender and bifid with patch of fine setae at base (fig. 12f); dorsal surface without scattered fine setae or scales. Left mandible (angulate) (figs. 12e, g) three apical teeth and 1–3 teeth on the inner margin of outer incisor (fig. 12g); inner incisor with three apical teeth, inner margin rugose at base; prosthema robust with patch of setae at base (fig. 12g); dorsal surface lacking scattered fine setae or scales. Maxillae (fig. 12c) with 2–3 long broad spines apically and 22–31 crown setae; with 4–5 subcrest setae on ventral surface, five hump setae, lateral margin below palp with long fine hair-like setae; palp III segmented, 0.45 mm long extending well beyond galealacinia, segment ratios (BL/BL (BL length) : ML/BL : AL/BL) 1.00 (0.25–0.26 mm) : 0.49–0.61 : 0.71–0.77; palp segment I slightly curved reaching apical third of galealacinia, with long fine hair-like setae on outer margin, segments I+II extending well beyond apex of galealacinia; segment II with long fine hair-like setae; segment III with rare long fine hair-like setae; segments II and III combined 1.26–1.32 times basal segment length, segment III length 1.16–1.59 times segment II length. Hypopharynx as for *S. elongatus*. Labium (figs. 13a, b) with glossae slightly shorter than paraglossae; glossae with 2–15 outer setae, 15–16 inner setae and >20 long

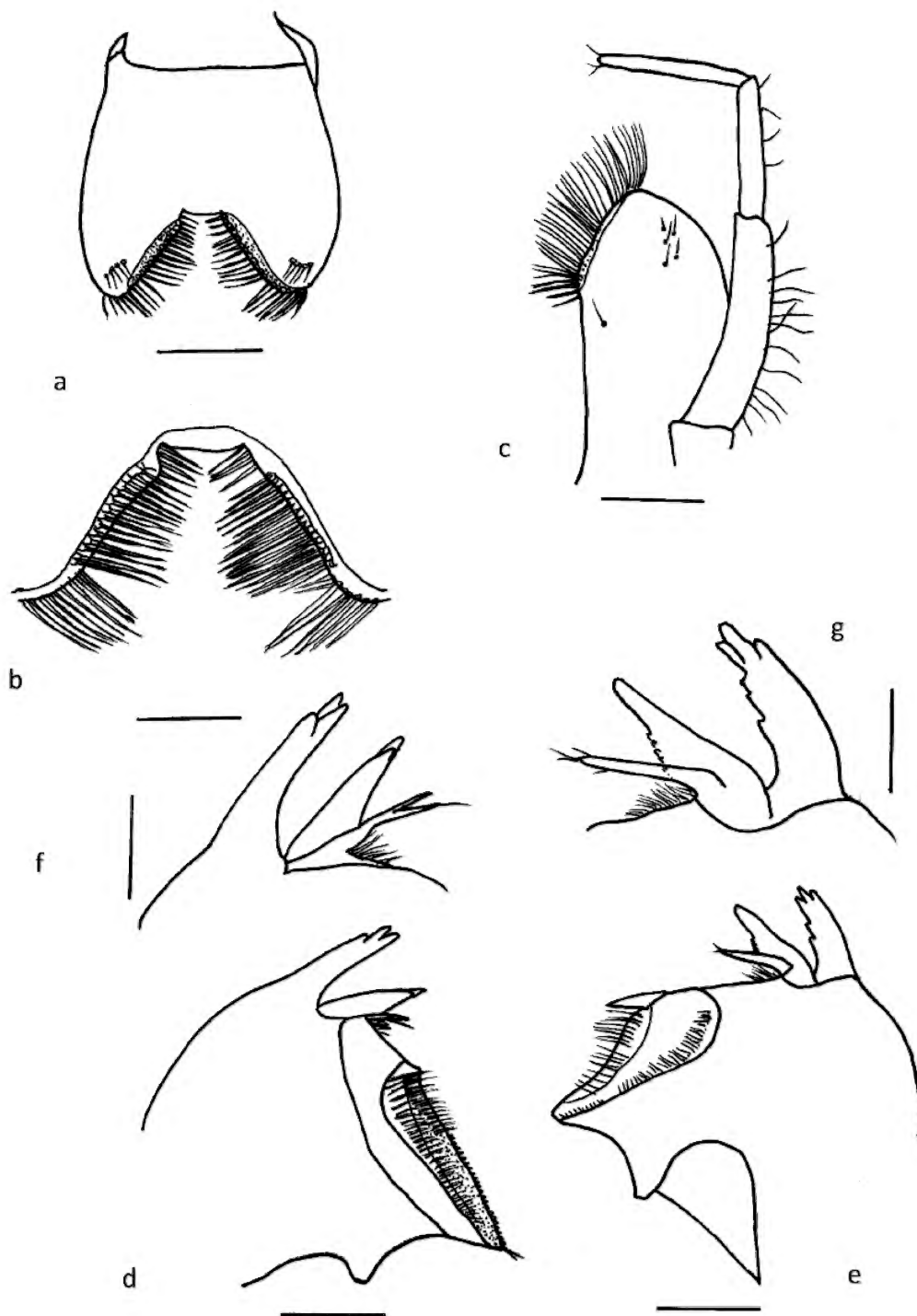


Figure 12. *Skolomystax goorudensis*: a, labrum; b, labrum notch; c, maxilla; d, right mandible; e, left mandible; f, right mandible incisors; g, left mandible incisors. Scale lines: a, c–e = 0.15 mm; b, f, g = 0.07 mm.

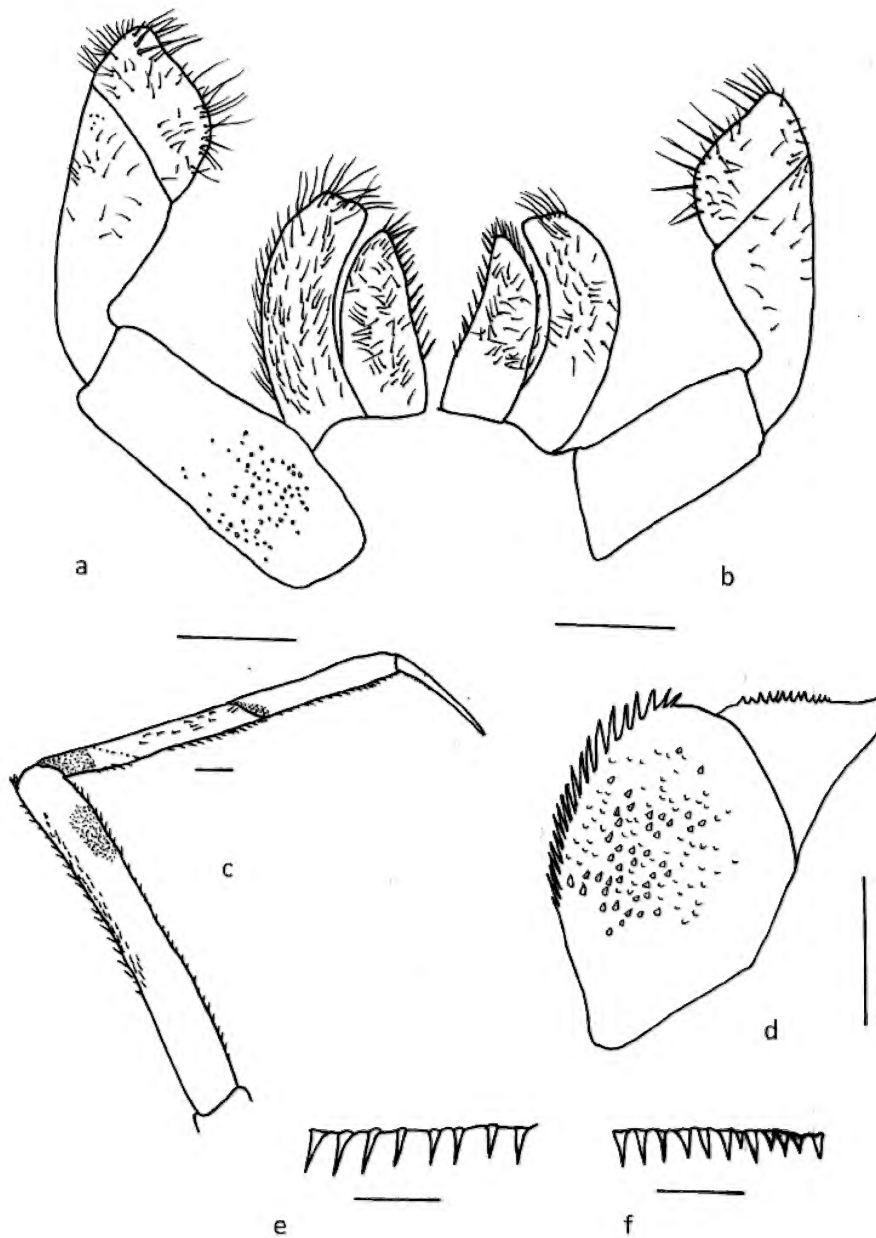


Figure 13. *Skolomystax goorudensis*: a, labium dorsal; b, labium ventral; c, leg; d, paraproct; e, tergite spines; f, sternite spines. Scale lines: a–f = 0.15 mm.

fine setae on dorsal surface (fig. 13a); paraglossae curved medially, truncate apically, with four rows of long setae dorsally; ventral surface with scattered fine setae (fig. 13b), labial palp

3-segmented, 0.72–0.75 mm long, outer margin of basal and mid-segments without setae, apical segment with fine hair-like setae on margin, segment I length 2.77–3.05 times width, slightly



shorter than segments II and III combined (1.02–1.28), segment II apically expanded and longer on outer margin than inner margin; segment III sub-rectangular and slightly falcate with numerous 16–17 long robust and short fine setae on apical margins, dorsal surface with 3–5 long robust setae distally, segment ratios (BL/BL (BL length) : ML/BL : AL/BL) 1.00 (0.32–0.37 mm) : 0.81–1.05 : 0.20–0.23.

**Legs:** foreleg (fig. 13c) 2.72–2.88 mm long (not including claw length) with ratios of 1.00 (1.19–1.28 mm) : 0.65–0.67 : 0.57–0.63 : 0.35 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.55–0.61 times length of tarsus. Fore femur 5.80–6.02 times longer than wide with subapical elongated dark band partially divided, dorsal margin of fore femora with row of 16–17 short sharply pointed robust setae with subapical pair of short, ventrally with 13–16 sharply pointed short setae. Fore tibia with basal dark patch and whole segment shaded, without setae or scattered fine setae on outer margin inner/posterior surface with 10–11 sharply pointed setae. Fore tarsus shaded, without setae on outer margin, inner margin with single distinct row of 23–26 short sharply pointed setae. Tarsal claw with two similar rows of denticles in basal half. Middle leg 2.94–3.03 mm long (not including claw length), segment ratios of 1.00 (1.34 mm) : 0.61–0.63 : 0.56–0.65 : 0.30–0.37 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.46–0.67 times length of tarsus, femur 5.65–8.17 times longer than wide with subapical elongate dark band, partially divided, dorsal margin of mid-femora with row of 19–31 short sharply pointed robust setae with subapical pair of short, robust setae; ventrally with 13–24 sharply pointed short setae. Mid-tibia without setae and scattered fine setae on outer and 12–32 setae on inner margin. Mid-tarsus without setae on outer margin and inner margin with single distinct row of 16–24 short sharply pointed setae. Tarsal claw with two similar rows of denticles in basal half. Hind leg length 2.95–3.00 mm, segment ratios of 1.00 (1.30–1.43 mm) : 0.58–0.70 : 0.53–0.57 : 0.34–0.36 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.60–0.68 times length of tarsus, hind femur 6.03–7.97 times longer than wide with subapical dark band, dorsal margin of hind femora with row of 19–22 short sharply pointed robust setae with subapical pair of short, robust setae; ventrally with 14–18 sharply pointed short setae. Hind tibia without setae or fine setae on outer margin, inner margin with 14–16 setae. Hind tarsus without setae on outer margin and inner margin with single distinct row of 21–26 short sharply pointed setae. Tarsal claw with two similar rows of denticles in basal half.

**Abdomen:** abdominal tergites with dark colour pattern on segments V and VI and segments IX and X (fig. 25f). Abdominal tergites I–X with numerous short triangular spines on posterior margins, those on posterior segments 3.00 times longer than basal width, bases of spines widely separate, twice width of spines (fig. 13e). Surfaces of terga with pointed scales and scale bases. Sternites with short triangular spines on posterior margin of segments IV–IX, long spines 2.40 times longer than basal width, short spines half-length of long spines, base of spines nearly contiguous (fig. 13f). Paraprocts (fig. 13d) with 22 marginal spines, surface with scale bases.

**Adults:** unknown.

## Discussion

The absence of setae on the outer margins of the tibiae and tarsi differentiates *S. goorudensis* from *S. elongatus*, *S. brevis* and *S. paschei*. The very deep labral notch with an angle of near 90° distinguishes *S. goorudensis* from all species lacking robust setae on the outer margins of the tibiae.

**Etymology:** From the type locality at Goorudee Rivulet, NSW.

**Distribution:** Southern NSW.

## *Skolomystax hawkingi* n. sp. (figs. 14, 15, 16, 25g)

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## *Centroptilum* spNQLD in Webb and Suter (2011)

**Material examined. Holotype:** nymph mounted on slides. Qld: Granite Creek at Mareeba to Mt Malloy Road, JWA1888, 16.98S 145.42E, 1 Jul 2009, JW, JHH; ANIC6–000092.

**Paratypes:** three nymphs mounted on slides. Qld: Granite Creek at Mareeba to Mt Malloy Road, JWA2094, 16.98S 145.42E, 1 Jul 2009, JW, JHH, ANIC6–000093; Endeavour Falls, Endeavour R, at Endeavour Falls Caravan Park, JWA1819, 15.37S 145.03E, 9 Oct 2009 JW, JHH, ANIC6–000094; Pioneer River at Marian-ReVeg, 21.14S 148.96E, JWA1421, MRH#1250035, ANIC6–000095; one female imago mounted on slide: Granite Creek at Mareeba to Mt Malloy Road, JWA507, 16.98S 145.42E, 1 Jul 2009, JW, JHH, ANIC6–000096.

**Other material examined.** Qld: Granite Creek at Mareeba to Mt Malloy Road, JWA1887 and JWA750, 16.98S 145.42E, 1 Jul 2009, JW, JHH; Murray Ck below Mt Charlton, JWA1422, 21.01S 148.74E, 21 Oct 1994, MRH#1240051; Condamine at Courbois Crossing, JWA1406, MRH#4223062; South Johnston River at Corsi's, 17.60S, 145.90E, JWA1405, MRH#1121017; St George R, 15.61S 144.02E, JWA1403, MRH#1051012; Walsh River at Rockwood, 16.98S 144.29E, JWA1402, MRH#919310A; MZL: Burdekin R at Sellheim, 19.998S 146.438E, 21 Oct 1994. Sandy Bed. DPI. One specimen on slide and two specimens in alcohol.

## Nymph – description

**Body:** 4.5–5.2 mm.

**Head:** uniformly coloured. Antennae with scape 1.23–1.48 times length of pedicel.

**Mouthparts:** labrum (fig. 14a) slightly wider than long (W/L = 1.29–1.44); labrum notch depth 0.70–0.79 times labrum length (fig. 14b), lacking lateral projections, notch depth 0.22–0.31 times notch width, notch angle approx. 96°, notch lined with 21–25 fimbriate setae; ventrally with dense patch of >20 fimbriate setae apically, numerous scattered fine setae dorsally with numerous scattered long fine setae. Right mandible (planate) (figs. 14e, g) with two apical teeth and a small tooth on outer margin of outer incisor, lacking lateral spine on inner margin of outer incisor; inner incisor with three indistinct teeth, inner margin smooth (fig. 14g); prostheca slender and bifid with patch of fine setae at base (fig. 14g); dorsal surface without scattered fine setae and scales. Left mandible (angulate) (figs. 14f, h) three apical teeth and one tooth on the inner margin of outer incisor; inner incisor with three apical teeth, inner

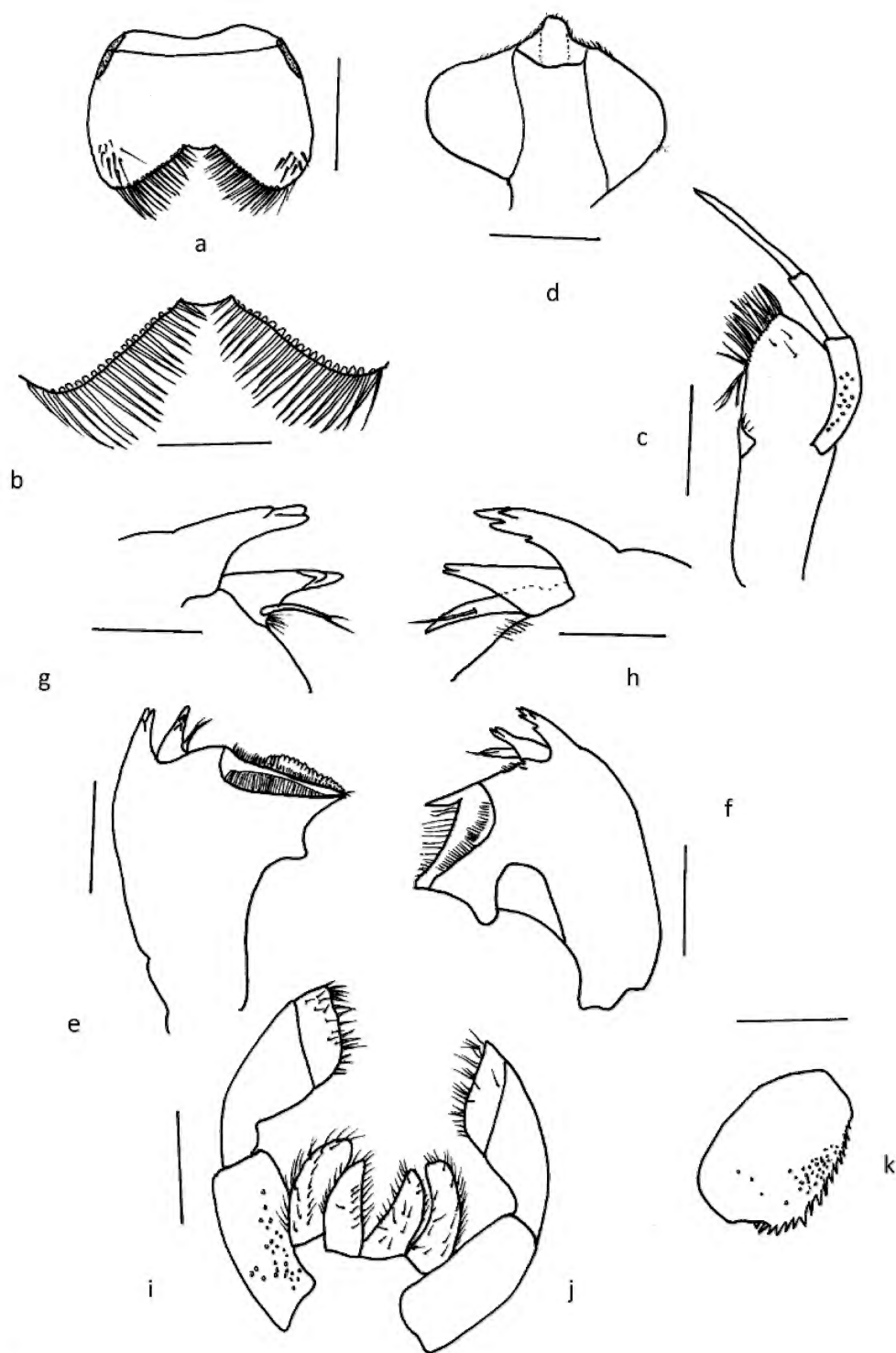


Figure 14. *Skolomystax hawkingi*: a, labrum; b, labrum notch; c, maxilla; d, hypopharynx; e, right mandible; f, left mandible; g, right mandible incisors; h, left mandible incisors; i, labium dorsal; j labium ventral; k, paraproct. Scale lines: a, c-f, i-k = 0.15 mm; b, g, h = 0.07 mm.

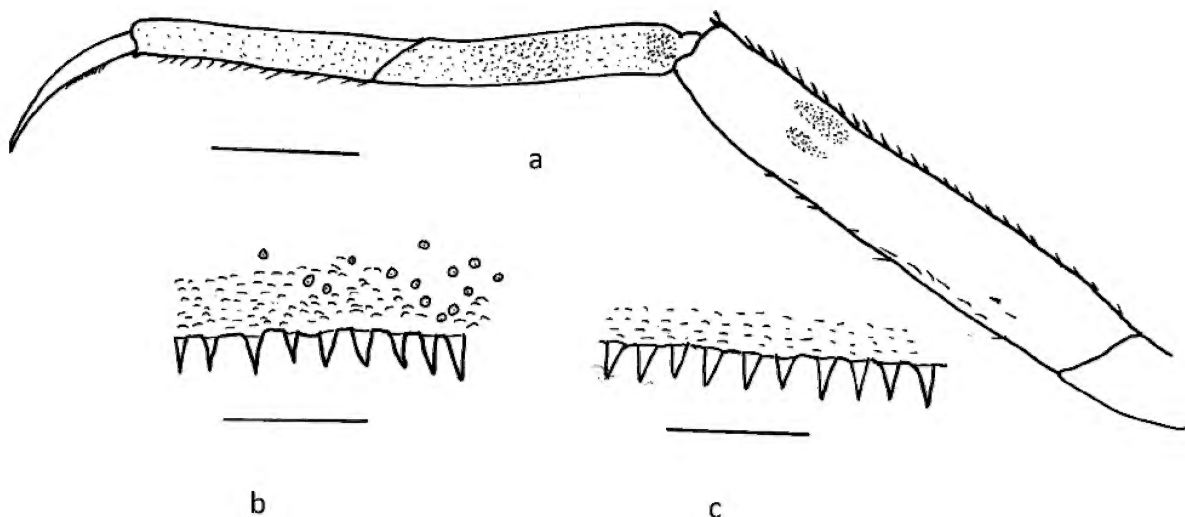
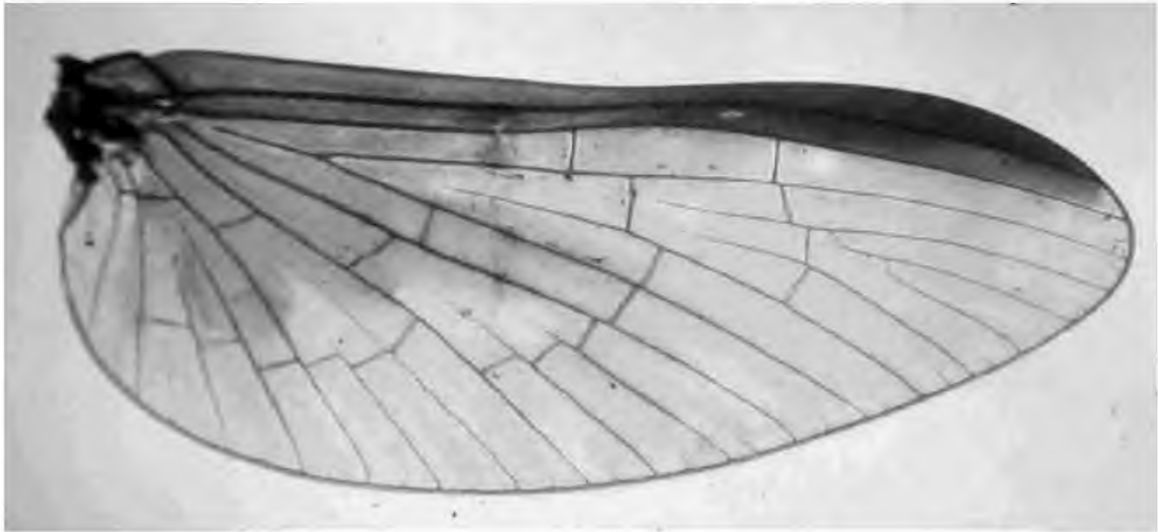


Figure 15. *Skolomystax hawkingi*: a, leg; b, tergite spines; c, sternite spines. Scale lines: a = 0.15 mm; b, c = 0.07 mm.

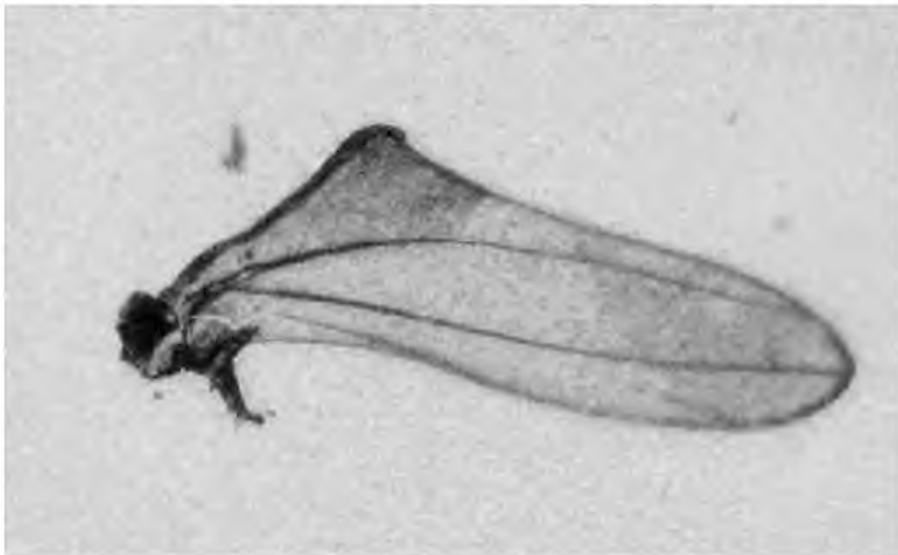
margin expanded, slightly rugose; prostheca robust bifid with patch of setae at base (fig. 14h); dorsal surface lacking scattered fine setae and scales. Maxillae (fig. 14c) with canines distinctly broader than lacinial setae, with 1–4 subcrest setae on ventral surface, 3–6 hump setae, and 20–24 lacinial setae, lateral margin below palp lacking fine setae; maxillary palp 3-segmented, length of palp 0.26–0.31 mm, palp extending well beyond apex of galealacinia, segment I extends to apical third of galealacinia, segments I and II combined extend beyond apex, segments with very sparse fine hair-like setae (difficult to see), segment II and III combined 1.24–1.79 times basal length, segment III 1.24–1.73 times length of segment II, segment I curved with approx. 10–15 round small tubercles; palp segment ratios (BL/BL (BL length) : ML/BL : AL/BL) 1.00 (0.14–0.17 mm) : 0.46–0.66 : 0.75–1.13. Hypopharynx (fig. 14d). Labium with glossae slightly shorter than paraglossae (figs. 14i, j); glossae with 5–7 outer setae, 6–9 long setae on inner margin, ventral surface >20 long fine hair-like setae; paraglossae curved medially, truncate apically and with single row of 11–14 long hair-like setae on outer margin, dorsal surface with two rows of long setae (fig. 14i), ventral surface with numerous long fine setae (fig. 14j); labial palp 3-segmented, palp length 0.38–0.52 outer margin of each segment without setae, segment I 2.14–2.46 times longer than wide, with segments II+III length 1.24–1.95 times basal length; segment II apically expanded and longer on outer margin than inner margin; segment III subrectangular and slightly falcate with 19–23 long robust and short fine setae on apical margin, dorsal surface with 4–6 long robust setae distally, ventral surface with scattered fine setae, segment ratios (BL/BL (BL length) : ML/BL : AL/BL) 1.00 (0.20–0.22 mm) : 0.66–1.14 : 0.19–0.24.

**Thorax:** pronotum with small distinct spots. Mesonotum uniformly coloured with small distinct dark spots. Sterna uniformly coloured.

**Legs:** foreleg 1.54–1.82 mm long (not including claw length) with ratios of 1.00 (0.69–0.88 mm) : 0.55–0.65 : 0.52–0.75 : 0.36–0.40 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.53–0.74 times length of tarsus. Fore femur 4.49–5.21 times longer than wide and with subapical dark band partially divided, dorsal margin of fore femora with row of 20–24 short sharply pointed robust setae with subapical pair of short, robust setae; ventrally with 10–18 sharply pointed short setae. Fore tibia with basal dark patch and segment uniformly shaded, lacking setae or scattered fine setae on outer margin, inner/posterior surface with 7–14 sharply pointed setae. Fore tarsus shaded but no dark patch, without setae on outer margin and spine setae on inner margin with single distinct row of 15–24 short sharply pointed setae. Tarsal claw with two similar rows of denticles in basal half. Middle leg (fig. 15a) 1.62–1.84 mm long (not including claw length), segment ratios of 1.00 (0.75–0.80 mm) : 0.55–0.65 : 0.55–0.67 : 0.36–0.37 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.54–0.68 times length of tarsus, femur 4.30–5.19 times longer than wide with subapical dark band, dorsal margin of mid-femora with row of 16–21 short sharply pointed robust setae with subapical pair of short, robust setae; ventrally with 6–11 sharply pointed short setae. Mid-tibia without setae and scattered fine setae on outer and 7–10 setae on inner margin. Mid-tarsus without setae on outer margin and inner margin, with single distinct row of 15–19 short sharply pointed setae. Tarsal claw with two similar rows of denticles in basal half. Hind leg length 1.62–1.81 mm, segment ratios of 1.00 (0.78–0.90 mm) : 0.47–0.57 : 0.49–0.54 : 0.29–0.39 (femur:



a



b

Figure 16. *Skolomystax hawkingi*: a, forewing of female imago, length = 6.0mm; b, hindwing of female imago, length = 1.1 mm.

tibia: tarsus: claw measured on outer margin), tarsal claw 0.57–0.75 times length of tarsus, hind femur 4.63–6.08 times longer than wide with subapical dark band, dorsal margin of fore femora with row of 22–25 short sharply pointed robust setae with subapical pair of short, robust setae; ventrally with 10–19 sharply pointed short setae. Hind tibia without setae and scattered fine

setae on outer and 8–11 setae on inner margin. Hind tarsus without setae on outer margin and inner margin, with single distinct row of 13–17 short sharply pointed setae. Tarsal claw with two similar rows of denticles in basal half.

*Abdomen*: abdominal tergites marked with fine dark spotting (fig. 25g), segments II–VII with a dark patch on lateral margins,

dark colour pattern on segments V, anterior area of VI dark. Abdominal terga with numerous short triangular spines on posterior margins present on terga I–X, those on posterior segments 2.00–2.44 times longer than basal width, bases of spines separated by approximately width of spine (fig. 15b). Surfaces of terga with pointed scales and scale bases. Sternites with short triangular spines on posterior margin on segments IV–IX, spines 1.70–2.08 times longer than basal width, bases of spines separated (fig. 15c). Gills I and II somewhat cordate and pointed, gills III–VII apically rounded. Paraprocts (fig. 14k) with 14–18 marginal spines, surface with scale bases. Cerci and terminal filament inner surfaces with long fine setae nearly to apex.

*Male*: unknown.

*Female*: forewing 5.7–6.0 mm; hindwing 1.1 mm. Head pale brown with pair reddish brown longitudinal stripes on vertex. Pronotum pale brown, paler medially and with longitudinal brown stripe and small pair submedian reddish brown spots. Mesonotum pale brown and with pair submedian reddish brown spots on anterior margin. Metanotum pale brown, metascutum pale with pair reddish brown spots basally. Forewing (fig. 16a) transparent with slight brown tinge between C and R<sub>1</sub>, all marginal intercalaries single, longitudinal veins yellowish to brownish; area between C and Sc with 7–8 crossveins in pterostigma, 0 crossveins basal of bulla and 2–3 crossveins between bulla and pterostigma. Hindwing narrow (fig. 16b); costal projection with wide base and single point curved towards body; crossveins absent; three longitudinal veins and single intercalary between second and third veins; second longitudinal vein unforked; third longitudinal vein short, joining hind margin distal of apex of costal projection. Legs pale, femora with three orange bands. Abdominal terga pale brown, paler medially; tergum I reddish; tergum II with pale circle surrounded by reddish ring sublaterally; terga III–VII with pair transverse reddish brown dashes on posterior margin; terga III–VI and X with reddish median spot or streak near anterior margin; tergum V with distinct submedian pair reddish brown spots. Abdominal sterna pale, anterior margins of VII–X slightly darker. Cerci broken and missing.

## Discussion

The absence of setae on outer margins of the tibiae and tarsi differentiates this species from *S. brevis*, *S. elongatus* and *S. paschei*. *Skolomystax hawkingi* differs from all other species of *Skolomystax* except *S. leichhardti* in having fine dark spotting over the body and being restricted to northern Australia. From *S. leichhardti*, *S. hawkingi* differs by having the spines on the posterior margins of sterna IV–IX, vs. V–IX; left mandible inner incisor lacking distinct teeth on the inner margin vs. 1–3 in *S. leichhardti*; paraprocts with 14–18 teeth vs. 10–11; maxillary palp extends well beyond apex of galealacinia vs. just extending beyond galealacinia, and segments I and II combined extend beyond apex whereas in *S. leichhardti* palp segments I and II combined do not reach the apex of galealacinia; outer margin of femora with >15 spines vs. <15; inner margin of mid- and hind tarsi with >13 spines vs. <12 spines.

*Etymology*: the species is named in honour of our colleague John Hawking from the Murray Darling Freshwater Research Centre, who helped collect much of the type material in northern Qld.

*Distribution*: northern Qld.

## *Skolomystax leichhardti* n. sp. (figs. 17, 18, 25h, m)

urn:lsid:zoobank.org:act:4E008287-3F38-475C-AE47-C6C1AE6C3F8

## *Centropetillum* sp1 in Suter (1992)

## *Centropetillum* spARR in Webb and Suter (2011)

*Material examined*. *Holotype*: nymph and associated male imago mounted on slides. NT: Magela Ck near Corndorf Billabong, PS430, 12.62S 132.88E, 17 May 1988, PS, AW, PC, cast skin and male imago, ANIC6-000088.

*Paratypes*: one nymph and one reared male imago mounted on slides; Magela Ck at Ranger outlet, PS420, 12.68S 133.93E, 19 May 1988, PS, AW, PC, ANIC6-000089, 90; one male imago on two slides, South Alligator R. Site 1 at Gimbat OSS field station, PS431, 13.60S 132.60E, 30 Sept 1988, PS, AW, PC, ANIC6-000091.

*Other material examined*. NT: nymph; pool nr Sandy Billabong, JWA1380, 12.62S 132.87E, 28 May 1988, PS, AW, PC; Barramundie Ck, JWA2478/2485, 13.31S 132.44E, 2 Oct 2009, JW, JHH, PS, MH; Magela Ck below Bowerbird Billabong, 12.78S 133.03E, May 1988, PS, AW, PC; Magela Ck below Magela Falls, 12.77S 133.10E, April 1989, PS, AW, PC; Jim Jim Ck above Jim Jim Falls, 13.28S 132.85E, May 1988, PS, AW, PC; Magela Ck upstream of Georgetown Billabong, 12.68S 132.93E, 4 Feb 2019, JH.

## Nymph – description

*Body*: 4.5–5.4 mm; terminal filament length 1.00–1.45 mm; caudal filaments 2.73 mm; caudal filaments 0.6 times body length, terminal filament 0.22–0.27 times body length.

*Head*: uniformly coloured with labrum tinged brown at base. Antennae with scape 1.23 times length of pedicel.

*Mouthparts*: labrum (fig. 17a) slightly wider than long (W/L = 1.25–1.37); notch depth 0.27 times notch width (fig. 17b) and 0.73 times labrum length, notch angle approx. 107°, lined with 19–25 setae; ventrally with numerous fimbriate setae apically, numerous scattered fine setae, apical corners with 12–15 long, robust setae, and laterally lacking setae; dorsally with numerous scattered long fine setae. Right mandible (planate) (figs. 17e, g) with three apical teeth on outer incisor, lacking lateral spine on inner margin of outer incisor (fig. 17g); inner incisor with broad surface and with three teeth and with 0–1 lateral tooth; prostheca slender and bifid with long setae, sparse patch of fine setae at base (fig. 17g); patch of broad setae at base of molar area; dorsal surface without scattered fine setae and scales. Left mandible (angulate) (figs. 17f, h) three apical teeth and 1–3 inner teeth on outer incisor; inner incisor with three apical teeth and 2–4 inner teeth giving a rough rugose appearance; prostheca robust bifid with sparse patch of setae at base (fig. 17h); dorsal surface lacking scattered fine setae and scales. Maxillae (fig. 17c) with canines distinctly broader than lacinial setae, 2–7 subcrest setae

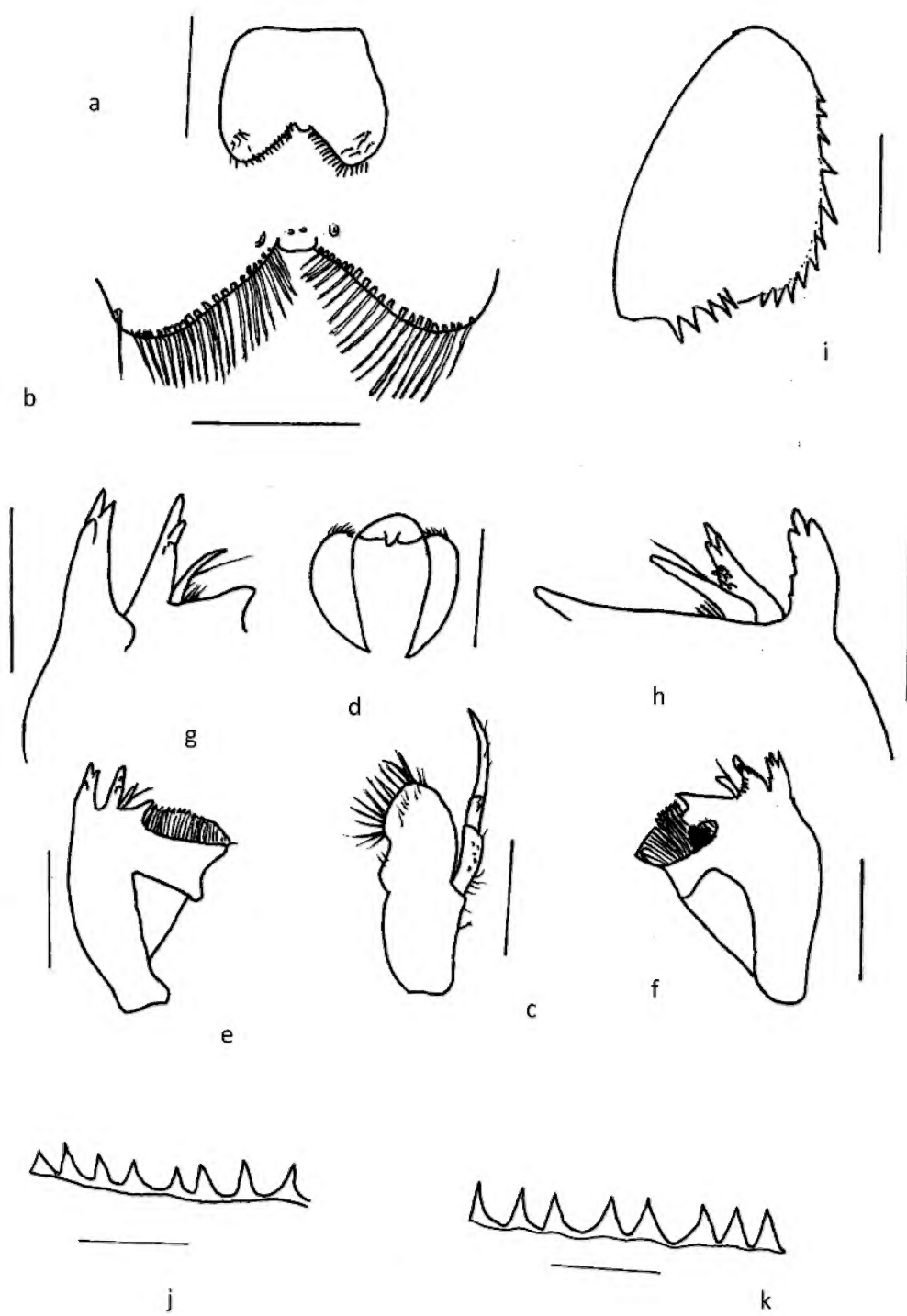


Figure 17. *Skolomystax leichhardti*: a, labrum; b, labrum notch; c, maxilla; d, hypopharynx; e, right mandible; f, left mandible; g, right mandible incisors; h, left mandible incisors; i, paraproct; j, tergite spines; k, sternite spines. Scale lines: a, c–f = 0.15 mm; b, g–k = 0.07 mm.

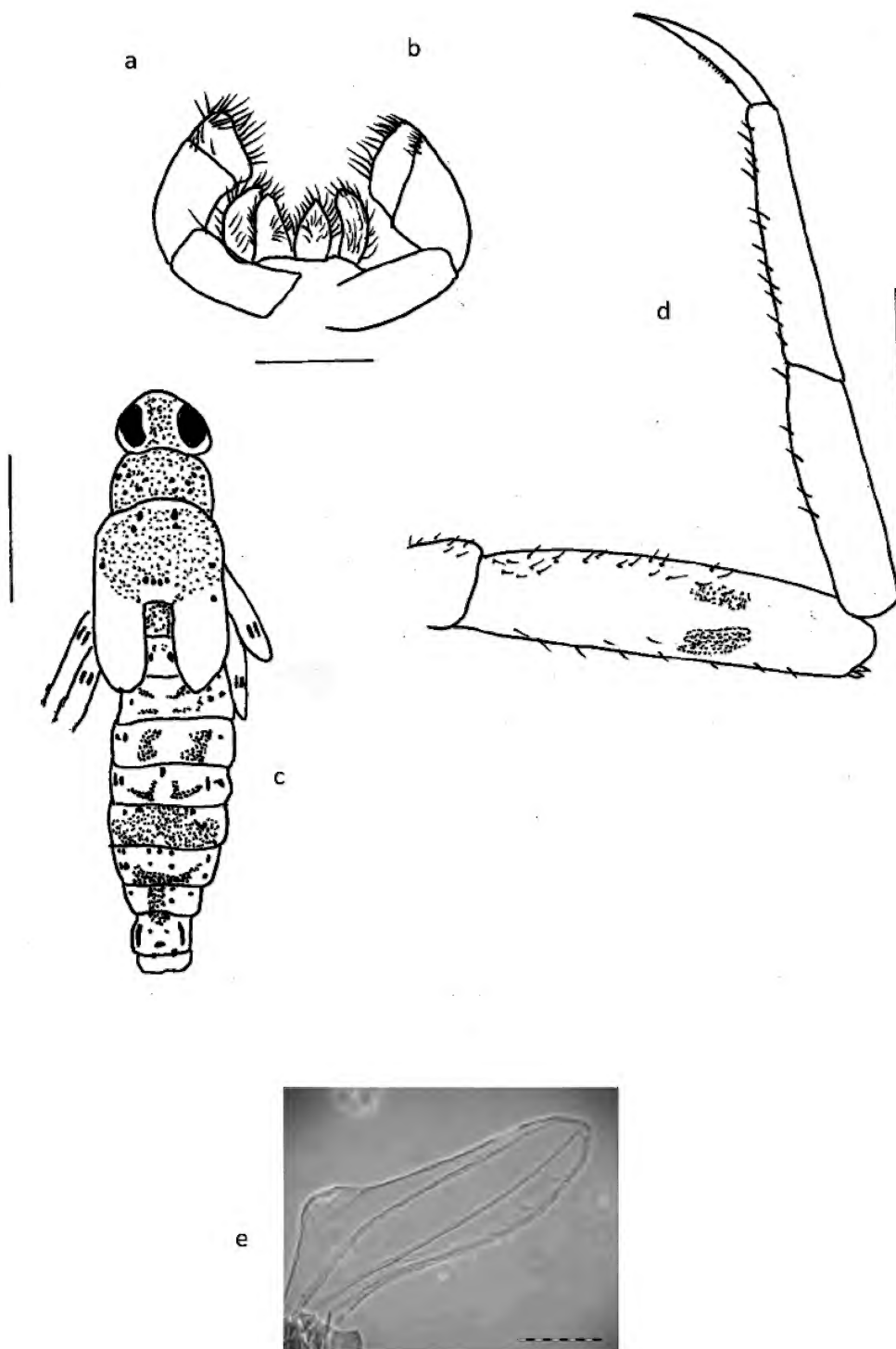


Figure 18. *Skolomystax leichhardti*: a, labium dorsal; b, labium ventral; c, body colour pattern; d, leg; e, hindwing of male imago. Scale lines: a, b, d = 0.15 mm; c = 1 mm; e = 0.1 mm.

on ventral surface, 2–5 hump setae and 27–28 lacinial setae, lateral margin below palp with few fine hair-like setae; maxillary palp 3-segmented, extending beyond apex of galealacinia, segment I extends to mid-galealacinia, with few fine lateral hair-like setae, segments I and II combined reach apical 1/3 of galealacinia (fig. 17c), all segment with fine hair-like setae, basal segment with numerous round tubercles; palp length 0.22 mm, palp segment ratios (BL/BL (BL length) : ML/BL : AL/BL) 1.00 (0.095 mm) : 0.82 : 1.27, length of segment II and III combined 2.09 times basal segment length, segment III 1.55 times length of segment 2. Hypopharynx (fig. 17d). Labium (figs. 18a, b) with glossae slightly shorter than paraglossae; glossae with 7–9 outer setae, 3–9 inner setae and two apically, >20 long fine setae on margins, dorsal surface (fig. 18a) with numerous long fine setae and single subapical long robust seta; paraglossae curved medially, truncate apically and with single row of 13–14 setae on outer margin, dorsal surface with numerous 11–14 long setae, ventral surface (fig. 18b) with numerous long fine setae on glossae and paraglossae; labial palp 3-segmented, 0.40–0.52 mm, outer margin of each segment without setae, basal segment 1.85–2.01 times longer than wide, slightly shorter than segments II and III combined, subrectangular, segment II apically expanded and longer on outer margin than inner margin; segment III subrectangular and slightly falcate with 16 long robust and short fine setae on margins, dorsal surface with 3–5 long robust setae distally, ventral surface with scattered fine setae, segment ratios (BL/BL (BL length) : ML/BL : AL/BL) 1.00 (0.17–0.22 mm) : 1.08–1.11 : 0.25–0.34, segment 2 and segment 3 combined 1.33–1.45 times longer than basal segment.

**Thorax:** pronotum with small distinct spots, with dark markings (figs. 18c, 25i, 25j). Mesonotum uniformly coloured. Sterna uniformly coloured.

**Legs:** foreleg 1.42–1.51 mm long (not including claw length) with segment ratios of 1.00 (0.62–0.65 mm) : 0.61–0.62 : 0.69–0.71 : 0.39–0.40 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.55–0.58 times length of tarsus. Fore femur 4.00–4.04 times longer than wide, with elongate pair of subapical dark bands (fig. 18d), dorsal margin of fore femora with row of 11–12 short sharply pointed robust setae with subapical pair of short, robust setae; inner margin with 14 sharply pointed long setae. Fore tibia without setae or hair-like setae on outer margin, inner surface with 8–10 long sharp setae. Fore tarsus without setae on outer margin, inner margin with single distinct row of 15–16 short sharply pointed setae, slight dark marking at base. Tarsal claw with two similar rows of denticles in basal half. Middle leg 1.48–1.70 mm long (not including claw length), mid-femur 5.52–5.58 times longer than wide with ratios of 1.00 (0.71–0.78 mm) : 0.57–0.59 : 0.52–0.57 : 0.37 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.71 times length of tarsus. Mid-femur with pair of elongate subapical dark markings, dorsal margin of fore femora with row of 10–11 short sharply pointed robust setae with subapical pair of short, robust setae; inner margin with 12–16 sharply pointed long setae. Mid-tibia without setae or hair-like setae on outer margin, inner surface with 0–5 long sharp setae. Mid-tarsus without setae on outer margin, inner margin with

single distinct row of 10–12 short sharply pointed setae. Tarsal claw with two similar rows of denticles in basal half. Hind leg length 1.28–1.49 mm, femur 4.92–5.30 times longer than wide with pair of elongate subapical dark markings, segment ratios 1.00 (0.56–0.87 mm) : 0.47–0.66 : 0.47–0.55 : 0.31–0.41 (femur: tibia: tarsus: claw measured on outer margin), tarsal claw 0.56–0.87 times length of tarsus, outer margin of hind femora with row of 8–10 sharply pointed robust setae with subapical pair of short, robust setae; inner margin with 10–15 sharply pointed short setae. Hind tibia without setae or hair-like setae on outer margin, 5–8 setae on inner margin. Hind tarsus without setae on outer margin and inner margin with single distinct row of 7–11 short sharply pointed setae. Tarsal claw with two similar rows of denticles in basal half.

**Abdomen:** abdominal tergites with dark colour pattern on segments V and anterior area of VI, pair of black spots on segment II and numerous minute black spots on all segments (fig. 25h), tergum I with small median reddish brown spot, terga III–V with pair transverse reddish brown dashes on posterior margin; tergum V with distinct submedian pair reddish brown spots. Abdominal terga I–X with numerous short triangular spines on posterior margins (fig. 17j), those on posterior segments 0.91–1.27 times longer than basal width, bases of spines separate by approximately width of spines. Sternites with triangular spines on posterior margin of segments V–IX, spines 1.25–1.30 times longer than basal width, bases of spines separated (fig. 17k). Gills I–III narrow and pointed, IV–VII ovate with slight acute apex. Paraprocts (fig. 17i) with 10–11 marginal spines, surface with scale bases. Cerci longer than terminal filament, slightly darkened distally, every other articulation darkly coloured, and inner surfaces with long fine setae nearly to apex.

**Adult male:** body length 3.8–4.5 mm. Dorsal turbinate eyes reddish-brown. Forewing length 3.6 mm, hyaline, opaque along costal margin and also at base of wing (Suter, 1992, fig. 110), all marginal intercalaries single and short; length 2.9 times width, pterostigma area opaque with 6–7 crossveins. Hindwing length 0.5 mm with basal costal projection and two main veins, second longitudinal vein unforked, costal projection and apex of wing slightly opaque (fig. 18d; fig. 110 in Suter, 1992). Terminal filament reduced to a stump. Foreleg segment ratios 0.77 : 1.00 (1.16 mm) : 0.58 : 0.43 : 0.31 : 0.16 : 0.11 (Suter, 1992).

**Etymology:** the species is named in honour of Ludwig Leichhardt, a German explorer and naturalist famous for his exploration of northern Australia.

## Discussion

The absence of setae on outer margins of the tibiae and tarsi differentiates this species from *S. brevis*, *S. elongatus* and *S. paschei*. *Skolomystax leichhardti* differs from all other *Skolomystax* species except *S. hawkingi* in having distinct dark spots over the body, broad maxillary canines, and being restricted to northern Australia. *Skolomystax leichhardti* differs from *S. hawkingi* in having posterior marginal spines on sterna V–IX, vs. IV–IX; distinct teeth on the inner margin of the left inner incisor vs. lacking distinct teeth; paraprocts with 10–11 teeth vs. 14–18; apex of maxillary palp segment II



combined not reaching apex of galealacinia in *S. leichhardti* vs. extending distinctly beyond the apex of galealacinia in *S. hawkingi*; outer margin of femora with <15 spines vs. >15; inner margin of mid- and hind tarsi with <12 spines vs. >13 spines. Females of *S. leichhardti* are slightly smaller than those of *S. hawkingi* and lack a distinct marking on the femora. Some of the nymphs of *S. leichhardti* have a colour morph with a distinctive median longitudinal dark stripe on the abdomen (similar to the colour morph of *S. elongatus*) and two stripes on thorax (fig. 25m)

*Distribution*: NT.

### *Skolomystax paschei* n. sp. (figs. 19, 20, 25i)

urn:lsid:zoobank.org:act:FB1BE4F7-8722-4BCB-931C-908400447643

*Material examined*. *Holotype*: nymph mounted on slides. NSW: MacLaughlin R, JWAANIC1, 36.65S 149.11E, 19 Dec 1974 EFR, ANIC 6-000079.

*Paratypes*: three nymphs mounted on slides. NSW: MacLaughlin R, JWAANIC2, 36.65S 149.11E, 23 Oct 1965, EFR, ANIC 6-000080; Bobundara Ck on Maffra Rd, JWA1431, 36.49S 148.99E, 19 Dec 1974, EFR, ANIC 6-000081; MacLaughlin R at Monaro Highway, south of Nimmitabel, JWA1632, 36.5722S 149.2847E, 29 Mar 2009, ANIC 6-000082.

### Nymph – description

*Body*: 6.7 mm.

*Head*: light without distinct brown markings. Antennae with scape 1.04–1.23 times length of pedicel.

*Mouthparts*: labrum (fig. 19a) 1.22–1.25 times wider than long; labrum notch shallow distinctly rectangular at base, lacking lateral projections (fig. 19b), notch angle approx. 130°, depth 0.19–0.22 times width; notch depth 0.82–0.84 times labrum length; notch lined with 19–22 fimbriate setae on each side, ventrally with numerous fimbriate setae apically, numerous scattered fine setae, apical corners with 12–17 long and robust setae and laterally with submarginal scattered row of 7–11 short robust setae. Right mandible (planate) (figs. 20a, c) with three apical teeth and lacking lateral spine on inner margin of outer incisor; inner incisor with broad surface and with three indistinct apical teeth incisors, inner margin smooth; prostheca slender, bifid with a long setule at midpoint, patch of fine setae at base (fig. 20c). Left mandible (angulate) (figs. 20b, d) with three apical teeth and 4–5 teeth on inner margin of outer incisor; inner incisor with three apical teeth, inner margin enlarged and rugose (fig. 20d); prostheca robust and simple with several long spines apically, with patch of setae at base (fig. 20d). Maxillae (fig. 19c) with 2–6 subcrest setae on ventral surface, 5–6 hump setae, and >20 lacinial setae, lateral margin below palp lacking setae; maxillary palp 0.51 mm long, palp extends well beyond apex of galealacinia, segment I extends just beyond mid-galealacinia, and segments I and II combined extend beyond apex of galealacinia, all segments with sparse very fine hair-like setae on outer margins (difficult to see); segments II and III combined 1.54 times basal length, segment III 1.52–1.55 times segment II length; segment ratios of 1.00 (0.26–0.27 mm) : 0.60–0.61 :

0.93–0.94. Hypopharynx (fig. 19d). Labium with glossae slightly shorter than paraglossae (fig. 20a, b); glossae with 5–7 setae on outer margins, inner with 8–9 fine setae, ventral surface with numerous long hair-like setae; paraglossae curved medially, truncate apically and with numerous long fine hair-like setae on outer margin and a multiple rows of long setae ventrally; labial palp 3-segmented, 0.87–0.98 mm long, outer margin of each segment lacking setae, segment ratios 1.00 (0.42–0.46 mm) : 0.82–0.88 : 0.25–0.26, segment I sub-rectangular 2.50–2.94 times longer than wide, segment II apically expanded and longer on outer margin than inner margin, dorsal surface with few setae; segment III subrectangular and slightly falcate with >20 long robust setae on apical margins, dorsal surface with four long robust setae distally; segments 2 and 3 combined 1.70–1.97 times basal segment length.

*Legs*: foreleg total length of 3.57 mm, segment ratios of 1.0 (1.58 mm) : 0.67 : 0.59 : 0.37, tarsal claw 0.63 times tarsal length. Fore femur 5.67 times longer than wide; outer margin of fore femora with 39 short sharply pointed robust setae, with subapical pair of long, pointed robust setae; inner margin with 37 short sharply pointed robust setae. Fore tibia slightly darker basally and apically, outer margin with 21 short sharp setae (fig. 20g), inner margins with 27 long sharp setae. Fore tarsus without darker markings, with outer margin with lacking robust setae, inner margin with 38 long sharp setae. Tarsal claw with two similar rows of denticles in basal half. Middle leg total length of 3.70 mm with segment ratios of 1.00 (1.68 mm) : 0.67 : 0.54 : 0.39, tarsal claw 0.72 times tibia length. Mid-femur 6.06 times longer than wide; outer margin of fore femora with 48 short sharply pointed robust setae and with subapical pair of long, pointed robust setae; inner margin with 33 short sharply pointed robust setae. Mid-tibia slightly darker basally, outer margin with 30 sharp setae, inner margins with 30 long sharp setae. Mid-tarsus without markings, outer margin with two sharp pointed robust setae, inner margin with 40 long sharp setae. Tarsal claw with two similar rows of denticles in basal half. Hind leg total length 3.78–3.85 mm, with segment ratios of 1.00 (1.74 mm) : 0.61–0.66 : 0.54–0.56 : 0.33–0.36, tarsal claw 0.58–0.67 times tarsal length. Hind femur 6.53–7.13 times longer than wide; outer margin of hind femora with 37–48 short sharply pointed robust setae and scattered fine setae and with subapical pair of long, pointed robust setae; inner margin with 34–37 short sharply pointed robust setae. Hind tibia slightly darker basally, outer margin with 10–27 short sharp setae, inner margins with 28–32 long sharp setae. Hind tarsus without dark markings, with outer margin with 0–2 sharp robust setae, inner margin with 33–35 long sharp setae. Tarsal claw with two similar rows of denticles in basal half.

*Abdomen*: abdominal tergites with a distinct colour pattern (fig. 25i), dark lateral marks on segment II–VII, dark shaded on III–IV, darker saddle on V and VI, light VII and VIII and dark IX with medial Y-shaped light marking segment X, dark patch on anterior margin. Posterior margin of abdominal terga with long and short and widely spaced spines (fig. 19f), long spines length 2.60–3.07 times width and short spines 0.50–0.67 times long spine. Gills I and II somewhat cordate, gills III–VII apically rounded. Sterna II or III–IX with long spines of equal length

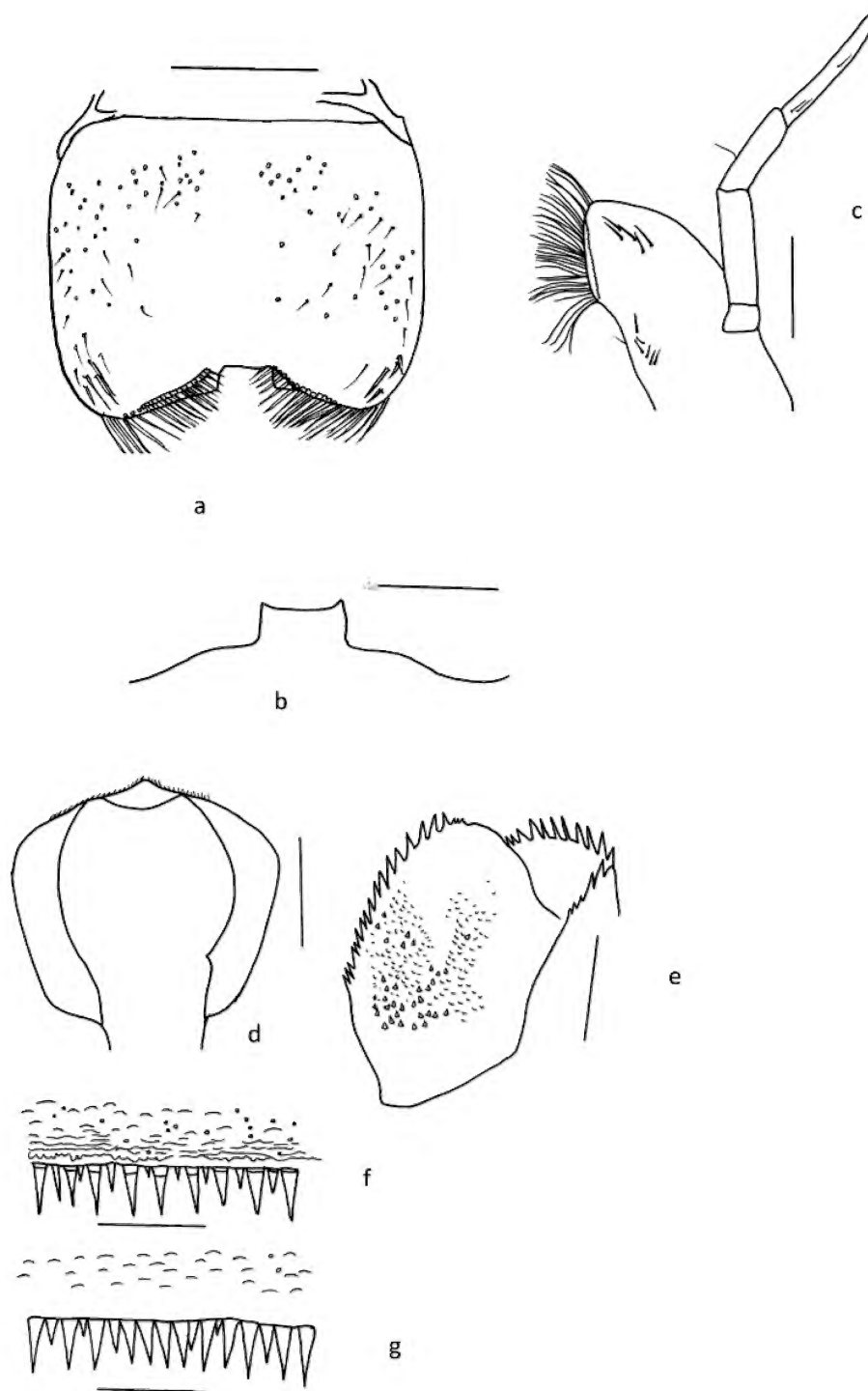


Figure 19. *Skolomystax paschei*: a, labrum; b, labrum notch; c, maxilla; d, hypopharynx; e, paraproct; f, tergite spines; g, sternite spines. Scale lines: a, c–f = 0.15 mm; b, g = 0.07 mm.

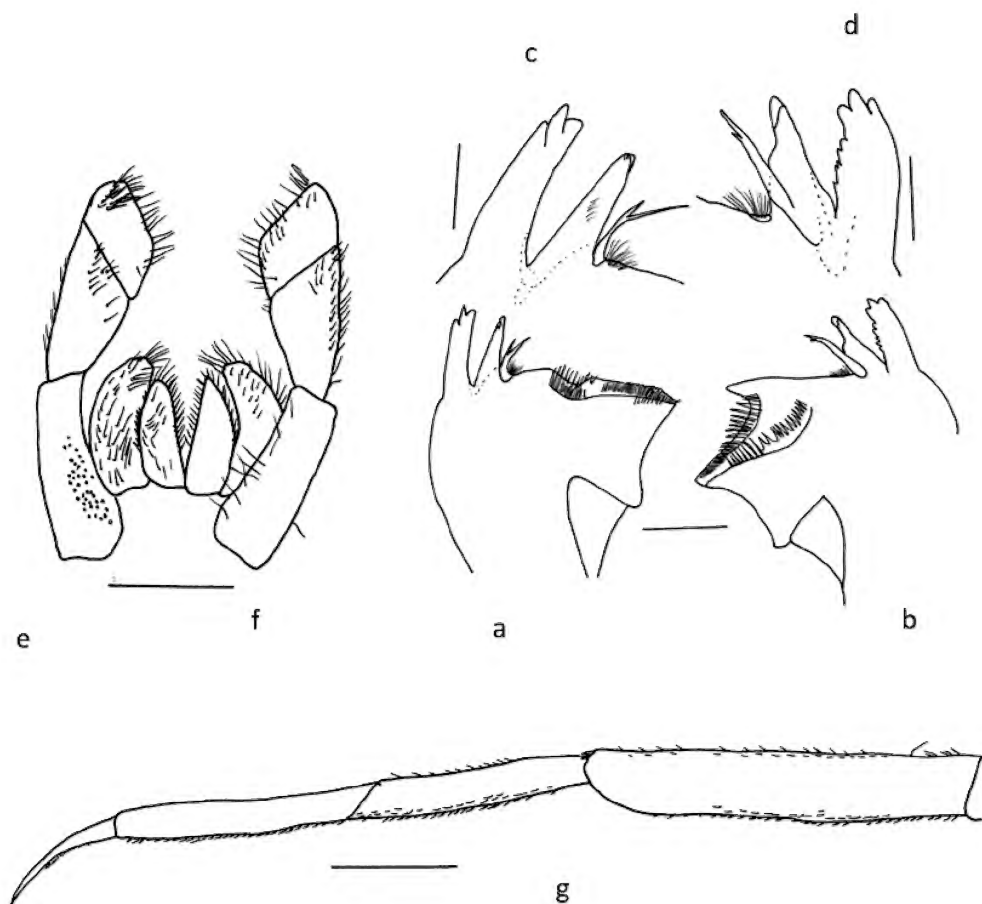


Figure 20. *Skolomystax paschei*: a, right mandible; b, left mandible; c, right mandible incisors; d, left mandible incisors; e, labium dorsal; f, labium ventral; g, leg. Scale lines: a, b, e, f, g = 0.15 mm; c, d = 0.07 mm.

(2.42–2.47 times longer than wide) with occasional short inter-spines (0–3) between long spines on posterior margin, bases contiguous (fig. 19g). Paraprocts (fig. 19e) with 21–23 marginal spines, surface with scattered scale bases. Cerci and terminal filament subequal in size, slightly darkened distally, every other articulation darkly coloured, and inner surfaces with long fine setae nearly to apex.

*Adults*: unknown.

*Etymology*: Named in honour of J-LG's late father-in-law, Michel Pasche.

*Distribution*: NSW.

## Discussion

The presence of robust setae on the outer margins of the tibiae and tarsi differentiates *S. paschei* from all other known species

except *S. elongatus* and *S. brevis*. The absence of black markings on the base of the mandibles, labrum and genae, the presence of alternating short and long spines on the posterior margins of the terga and spines on posterior margins of sterna II or III–IX distinguishes *S. paschei* from *S. brevis*. *S. paschei* differs from *S. elongatus* in having a distinctly broad notch of the labrum (notch angle 130°) vs. a shallowly angled notch (notch angle 100°) and more numerous spines on the outer margins of the femora.

## *Skolomystax tasmaniensis* n. sp. (figs. 21, 22, 25j)

urn:lsid:zoobank.org:act:AB4BAE04-2561-480F-9B41-C9E5F475BEA1

## *Centroptilum* spTAS in Webb and Suter (2011)

*Material examined*. *Holotype*: nymph mounted on slides. Tas: Shannon R at C178 Waddamana Rd, JWA357, 42.05S 146.76E, 1 Mar 2008, JW, JHH, ANIC6–000111.

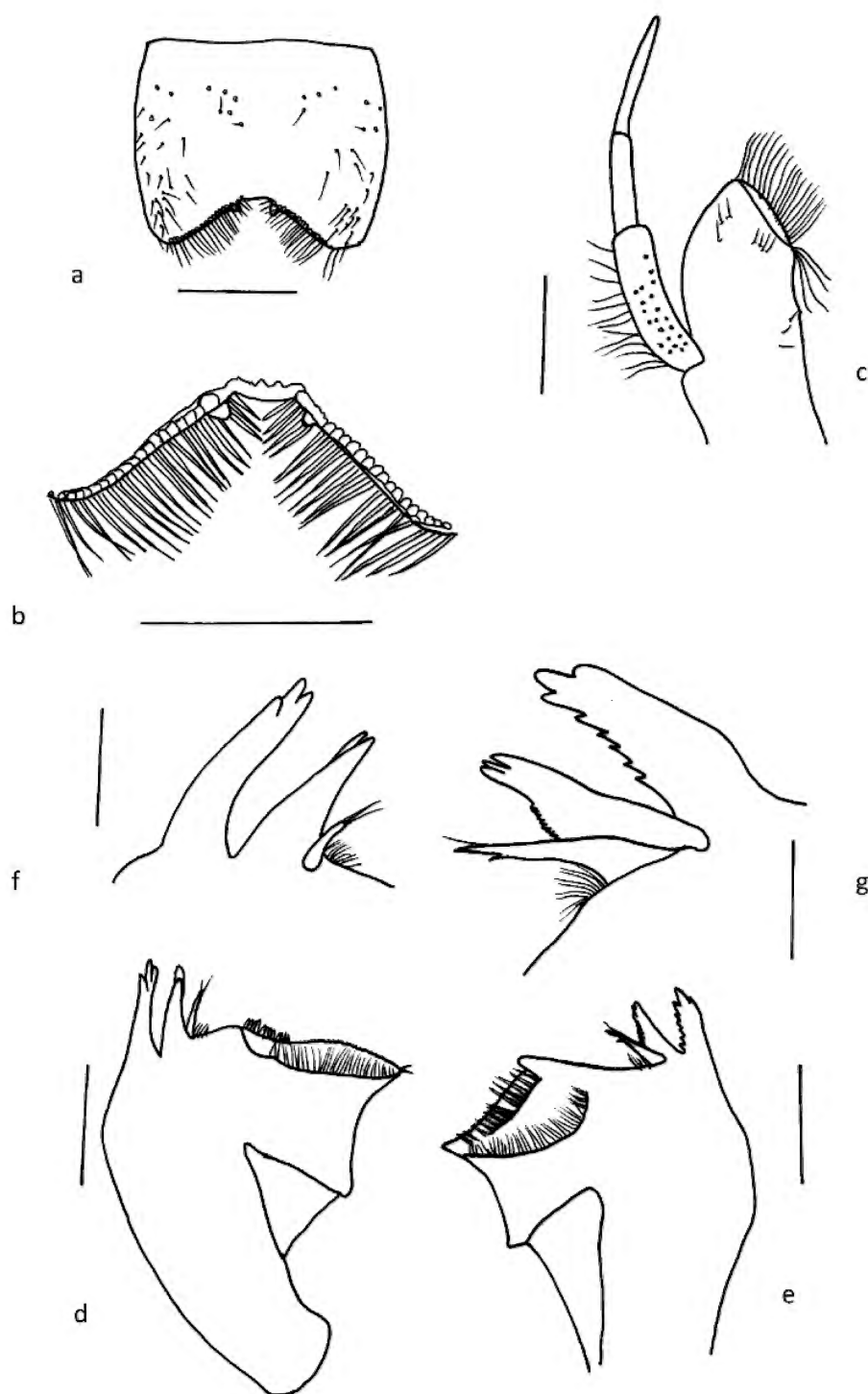


Figure 21. *Skolomystax tasmaniensis*: a, labrum; b, labrum notch; c, maxilla; d, right mandible; e, left mandible; f, right mandible incisors; g, left mandible incisors. Scale lines: a, c–e = 0.15 mm; b, f, g = 0.07 mm.

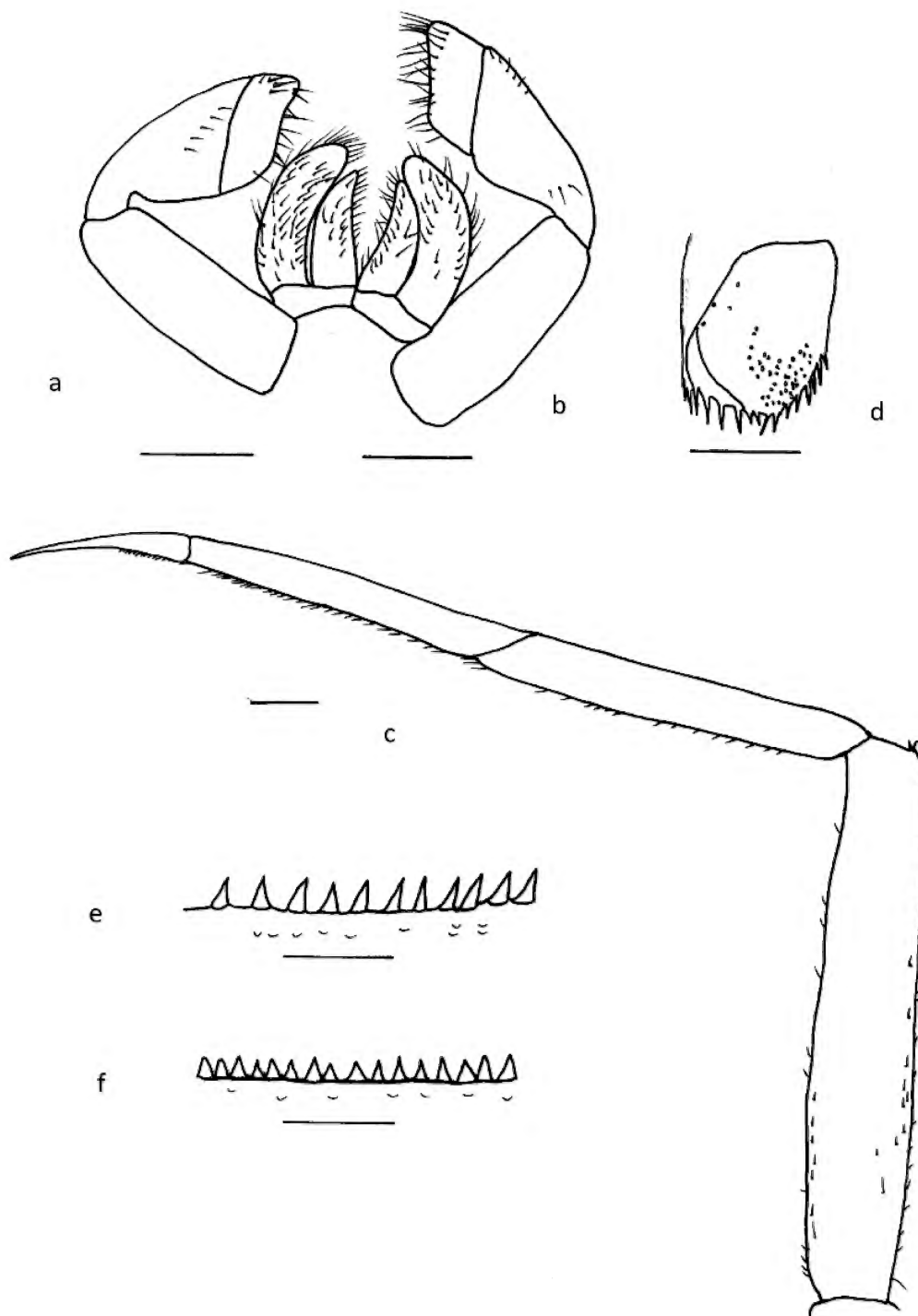


Figure 22. *Skolomystax tasmaniensis*: a, labium dorsal; b, labium ventral; c, leg; d, paraproct; e, tergite spines; f, sternite spines. Scale lines: a–f = 0.15 mm.

**Paratypes:** seven nymphs mounted on slides. Tas: Emu R at Fern Glade Reserve near Burnie, JWA342, 41.0843S 145.9190E, 26 Feb 2008, JW, JHH, ANIC6-000112, same location, JWA343, ANIC6-000113; Wilmot R at Alma Reserve, PS514, 41.27S 146.23E, 13 Oct 1994, Tas MRH, ANIC6-000114; St Patricks R Nunamara, PS589, 41.40S 147.30E, 29 Sept 1994, Tas MRH, ANIC6-000115; Inglis R on Jessie Rd, PS541, 41.10S 145.58E, 19 Oct 1994 Tas MRH, ANIC6-000116; Franklin R lower Reaches C5, PS561, 41.28S 146.60E, 13 Oct 1994, Tas MRH, ANIC6-000117; Bronte Lagoon PS571, 42.1845S 146.5036E, 16 March 2020, RT, ANIC6-000118.

**Other material examined.** Tas: Elizabeth R at Campbell Town, PS63-66, 41.95S 147.48E, 9 Mar 1994, PS; Wilmot R at Alma Reserve, PS511-513, 514, 41.27S 146.23E, 13 Oct 1994, Tas MRH; Wilmot R on Spelman Rd, PS518-520/522, 41.35S 146.17E, 13 Oct 1994, Tas MRH; Dasher R off Claude Rd, PS516/517, 41.45S 146.25E, 11 Oct 1994, Tas MRH; Inglis R on Jessie Rd, PS540, 542, 41.10S 145.58E, 19 Oct 1994, Tas MRH; Franklin R lower reaches C5, PS560, 41.28S 146.60E, 13 Oct 1994, Tas MRH; South Esk R at Beauty Flat near Mathinna, PS558/559, 41.52S 147.98E, 27 Sept 1994, Tas MRH; Leven R downstream of Gunns Plains, PS534-537, 41.25S 146.05E, 13 Oct 1994, Tas MRH; Flowerdale R on Lapoinya Rd, PS538/539, 41.00S 145.58E, 19 Oct 1994, Tas MRH; Mersey R upstream of Union Bridge, PS562, 41.53S 146.45E, 17 Oct 1994, Tas MRH; Meander R upstream of Deloraine, PS563-566, 41.53S 146.63E, 17 Oct 1994, Tas MRH; Keith R on Farquhars Rd, PS588, 41.20S 145.45E, 19 Oct 1994, Tas MRH; MZL: Weld River at A3 E of Welborough, 41.212S 147.926E, 2 Mar 2008, JMW, JH; Emu River at Fern Glade Reserve near Burnie, JWA290, 41.084S 145.919E, 26 Feb 2008, JMW, JH.

### Nymph – description

**Body:** 6.2–10.0 mm; caudal filaments 0.35–0.47 times body length; terminal filament 0.86–0.96 times caudal filament length.

**Head:** uniformly pale, with some dark vermiculations on vertex, dorsal eyes of males orange. Antennae with scape 1.04–1.41 times length of pedicel.

**Mouthparts:** labrum (fig. 21a) 1.19–1.32 times wider than it is long; length at base of apical notch 0.74–0.79 times maximum length; labrum notch depth 0.24–0.32 times width (fig. 21b), notch angle approx.  $106^\circ$ , notch lined with 20–23 setae, ventrally with single row of fimbriate setae apically all similar length, numerous scattered fine setae, and laterally with submarginal scattered row of 4–9 robust setae; dorsally with numerous scattered long fine setae. Right mandible (planate) (figs. 21d, f) with three apical teeth, inner margin smooth; inner incisor with broad surface and with three indistinct teeth, inner margin lined with a comb of short hair-like setae; prostheca simple, very slender spine with 14 setae and with patch of fine setae at base (fig. 21f); dorsal surface without scattered fine setae or scales. Left mandible (angulate) (figs. 21e, g) with three apical teeth and 3–6 inner teeth on outer incisor giving a serrated appearance (fig. 21g); inner incisor with three apical teeth, with rugose expanded base on inner margin; prostheca robust and simple with several long spines apically, patch of setae at base (fig. 21g); dorsal surface without scattered fine setae and scales. Maxillae (fig. 21c) with 1–3 subcrest setae on ventral surface, 1–7 hump setae, and 25–33 lacinial setae; lateral margin below palp with few fine hair-like setae; palp 3-segmented, 0.21–0.47 mm long; palp segment I somewhat curved, reaching apical half of galealacinia,

long hair-like setae on lateral margins, segment I+II reaching beyond galealacinia, outer margins lacking setae but may be a few sparse fine hair-like setae; segments II and III together 1.10–1.46 times longer than segment I; segment II lacking setae but may be a few sparse fine hair-like setae; segment III lacking setae but may be a few sparse fine hair-like setae, 1.01–1.64 times length segment II; segment ratios BL/BL (BL in mm), ML/BL, AL/BL: 1.00 (0.19–0.26 mm) : 0.49–0.65 : 0.58–0.85. Hypopharynx: as for *S. elongatus*. Labium with glossae slightly shorter than paraglossae (figs. 22a, b); glossae with single row of 11–20 long setae on outer margin, dorsal surface with single fimbriate robust seta near apex, ventral surface with one row of long fine setae and single subapical long robust seta (fig. 22b); paraglossae curved medially, truncate apically and with single row of 16–18 long setae on outer margin, dorsal surface with numerous long setae in 3–4 rows and with dense apical patch of fine setae (fig. 22a), ventral surface with long fine setae; labial palp 3-segmented, 0.55–0.82 mm long, outer margin of each segment lacking setae, basal segment sub-rectangular length 1.75–3.37 times width, segments I and III combined 1.09–1.58 times segment I length; segment II apically expanded and longer on outer margin than inner margin, dorsal surface with oblique row of fine setae distally, ventral surface with scattered fine setae; segment III sub-rectangular and slightly falcate, with numerous 3–7 long robust and short fine setae on margins, dorsal surface with long robust setae distally, ventral surface with scattered fine setae; segment ratios 1.00 (0.24–0.35 mm) : 0.82–1.23 : 0.21–0.35 (BL/BL (BL in mm), ML/BL, AL/BL).

**Thorax:** pronotum without any distinct spots, light patch laterally and three light patches within a dark medial area. Mesonotum dark medial area with light area laterally; forewing pads with dark stripes. Sterna uniformly coloured.

**Legs:** foreleg length 1.90–2.99 mm with ratios of 1.0 (0.88–1.38 mm) : 0.52–0.62 : 0.53–0.68 : 0.30–0.37. Fore femur 3.90–5.36 times longer than wide at midpoint and with subapical elongated dark band, often separated into two dark bands by longitudinal pale area, and usually with dark band basally; dorsal margin of fore femora with row of 7–30 short sharp pointed spines with subapical pair of short globular setae; ventral margin with 2–24 short sharp pointed spines. Fore tibia slightly darker basally, without spines on outer margin, inner margin with 6–16 long pointed robust setae. Fore tarsus darker, without setae, spines, or fine setae on outer margin, inner margin with 18–27 long sharp pointed setae in two rows. Tarsal claw length 0.53–0.65 times length of tarsus, with two similar rows of denticles in basal half. Middle leg (fig. 22c) length 1.13–3.68 mm, segment ratios: 1.00 (1.05–1.88 mm) : 0.52–0.61 : 0.46–0.56 : 0.25–0.34; middle femur 4.65–6.61 times longer than wide; tarsal claw 0.52–0.63 times tarsal length, outer margin of femur with 16–29 short spine setae, inner margin with 10–24 short spine seta; mid-tibia and tarsus lacking spine setae on outer margin; inner margin of tibia with 9–18 short spine setae, and inner margin of tarsus with 18–23 spine setae; segment banding as for foreleg. Hind leg length 2.21–3.93 mm, segment ratios 1.00 (1.04–1.41 mm) : 0.51–0.69 : 0.52–0.58 : 0.29–0.37, tarsal claw 0.54–0.68 times length of tarsus; hind femur 4.60–8.13 times longer than wide; outer margin of femur with 11–34 short spine setae, inner margin

with 12–28 short spine setae; hind tibia and tarsus lacking spine setae on outer margin; inner margin of tibia with 11–36 short spine setae, and inner margin of tarsus with 17–35 spine setae; segment banding as for foreleg.

**Abdomen:** abdominal tergites with a distinct colour pattern (fig. 25j), segment I dark anteriorly with pale median area posteriorly with two red spots, segment II–IV pale with dark lateral marks, dark saddle on segments V and VI each with a postero-medial light patch, segment VII and VIII light segment, IX dark and segment X light. Abdominal terga I–X with numerous long spines on posterior margins, those on posterior segments 1.33–4.17 times longer than basal width (fig. 22e), bases of spines separate by approximately two times spine width. Sterna IV–IX with spines on posterior margin, spines contiguous, 1.47–2.77 times width (fig. 22f). Paraprocts (fig. 22d) with 11–25 marginal spines, surface with scale bases. Cerci and terminal filament subequal in length, slightly darkened distally, every other articulation darkly coloured, inner surfaces of cerci with long fine setae nearly to apex, and terminal filament with long fine setae on outer margins.

**Adults:** unknown.

**Etymology:** Named from Tas, where this species is endemic.

**Distribution:** Tas.

## Discussion

The absence of robust setae on the outer margins of the tibiae differentiates *S. tasmaniensis* from *S. elongatus*, *S. paschei* and *S. brevis*. It differs from *S. gippslandicus* and *S. dyarrii* in having the spines on the posterior margins of terga IV–IX vs. VI–IX or VII–IX. The absence of short spines between the long spines on the posterior margins of terga distinguishes *S. tasmaniensis* from *S. goorudensis*. The species most like *S. tasmaniensis* are *S. vulgaris* and *S. chionotos*, but they are not known to occur in Tas, where *S. tasmaniensis* is endemic, and *S. chionotos* has a maxillary palp with segment II longer than segment III as opposed to shorter than or subequal segment III. *Skolomystax tasmaniensis* has the inner margin of the left mandible rugose vs. a smooth inner margin in *S. vulgaris*.

## *Skolomystax vulgaris* n. sp. (figs. 23, 24, 25k)

urn:lsid:zoobank.org:act:7AB15BA4-C3C0-4DDE-AB3A-4DAEE3201474

## *Centropilum* sp1 in Webb and Suter (2011)

**Material examined. Holotype:** nymph mounted on slides. Vic: Rocky Valley River at Bogong Village, JWA85 36.81S 147.23E, 16 Jan 2008, JW, PS, ANIC6–000106.

**Paratypes:** four nymphs mounted on slides. Vic: Aire R at Beech Forest to Apollo Bay Rd, Otways Ranges, JWA1233, 38.67S 143.58E, 26 Nov 2008, JW, SM, ANIC6–000107; Tanjil R East Branch at Tanjil, JWA637, 37.94S 146.21E, 26 Mar 2008, EPA, ANIC6–000108; Buffalo Ck above Rollasons Falls, Mt Buffalo, JWA1755, 36.69S 146.82E, 22 Feb 2009, JW, ANIC6–000109. NSW: Paddy's R at C548, JWA1254 35.85S 148.14E 19 Mar 2009, JW, SM, ANIC6–000110.

**Other material examined.** NSW: Bedford Creek (N629) in the Blue Mts at altitude 530 m, PS182–184, 33.75S 150.48E, 28 Oct 1992; Paddy's

R at C548, 19 Mar 2009, JW, SM; N269 28 Oct 1992; N629 Bedford Creek in the Blue Mts, 33.75S 150.48E, altitude 530 m, MRH. Vic: Snowy Ck on Omeo Highway near Mitta Mitta, JWA2288/2289, 36.55S 147.38E, 16 Apr 2010, JW; Fyans Ck at Grampians Rd, JWA1234, 37.20S 142.55E, 25 Nov 2008, JW, SM; Tambo R at Bindi Station, PS157/158, 37.12S 147.82E, 17 Mar 1994, KH; Middle Ck on Middle Ck Rd, PS43, 4546, 38.40S 146.38E, 24 Oct 1979, LTCS; Cabungra R at Anglers Rest on Omeo Highway, PS162163, 36.99S 147.49E, 1 Oct 1982, Vic EPA. MZL: Triplet Falls, Youngs Creek, Great Otway National Park, 38.671S 143.494E, 27 Nov 2008, JW, SM, two slides and four specimens in alcohol.

## Nymph – description

**Body:** 6.4–9.6 mm; caudal filaments length 0.30–0.44 times body length.

**Head:** antennae with scape 1.01–1.19 times length of pedicel.

**Mouthparts:** labrum (fig. 23a) slightly wider than long (1.15–1.43); depth of notch 0.17–0.46 times width (fig. 23b), length at base of apical notch 0.74–0.93 times maximum length, notch angle approx. 103°, notch lined with 28–32 fimbriate setae on each side, ventrally with single row of fimbriate setae apically, numerous scattered fine setae, those at apical corners distinctly longer, and laterally with submarginal scattered row of 7–13 short robust setae; dorsally with numerous scattered long fine setae. Right mandible (planate) (figs. 23d, f) with three apical teeth on outer incisor, inner margin usually with zero but up to two teeth; inner incisor with broad surface and with three indistinct apical teeth, inner margin with a fine comb of very short hair-like setae; prostheca slender, bifid with long seta, patch of fine setae at base (fig. 23f). Left mandible (angulate) (figs. 23e, g) with three apical teeth and 2–5 teeth on inner margin of outer incisor; inner incisor with three apical teeth and bulge at base, smooth (fig. 23g); prostheca robust, with 13 long apical setae (fig. 23g), and with patch of setae at base. Maxillae (fig. 23c) with 2–6 subcrest setae on ventral surface, 2–6 hump setae, and 25–40 lacinial setae; lateral margin below palp with few fine long hair-like setae; palp 3-segmented 0.22–0.48 mm long, palp extending well beyond apex of galealacinia, segment I reaching apical third of galealacinia, segments I and II reaching just beyond apex of galealacinia, with long fine hair-like setae on outer margin of segment I; segment II short, lacking fine hair-like setae; segment III lacking fine hair-like setae, segments II and III combined 1.21–1.65 times basal length, segment III length 1.09–2.32 times length of segment II; segment ratios 1.00 (0.18–0.24 mm) : 0.43–0.66 : 0.72–1.08. Hypopharynx as for *S. elongatus*. Labium (figs. 24a, b) with glossae slightly shorter than paraglossae; glossae with single row of 8–16 setae on outer margin, 10–18 setae on inner margin, dorsal surface with fimbriate robust setae near apex, dorsal surface with numerous long fine setae (fig. 24a), ventrally with few fine setae (fig. 24b); paraglossae curved medially, truncate apically and with single row of long setae on outer margin, dorsal surface with numerous long setae (fig. 24a), ventral surface with numerous long fine setae (fig. 24b); labial palp 3-segmented, 0.61–0.79 mm long, outer margin of each segment lacking setae but may have few sparse fine hair-like setae, segment I sub rectangular, 2.36–4.43 times longer than wide, 0.94–1.30 times longer than segments II and III combined,

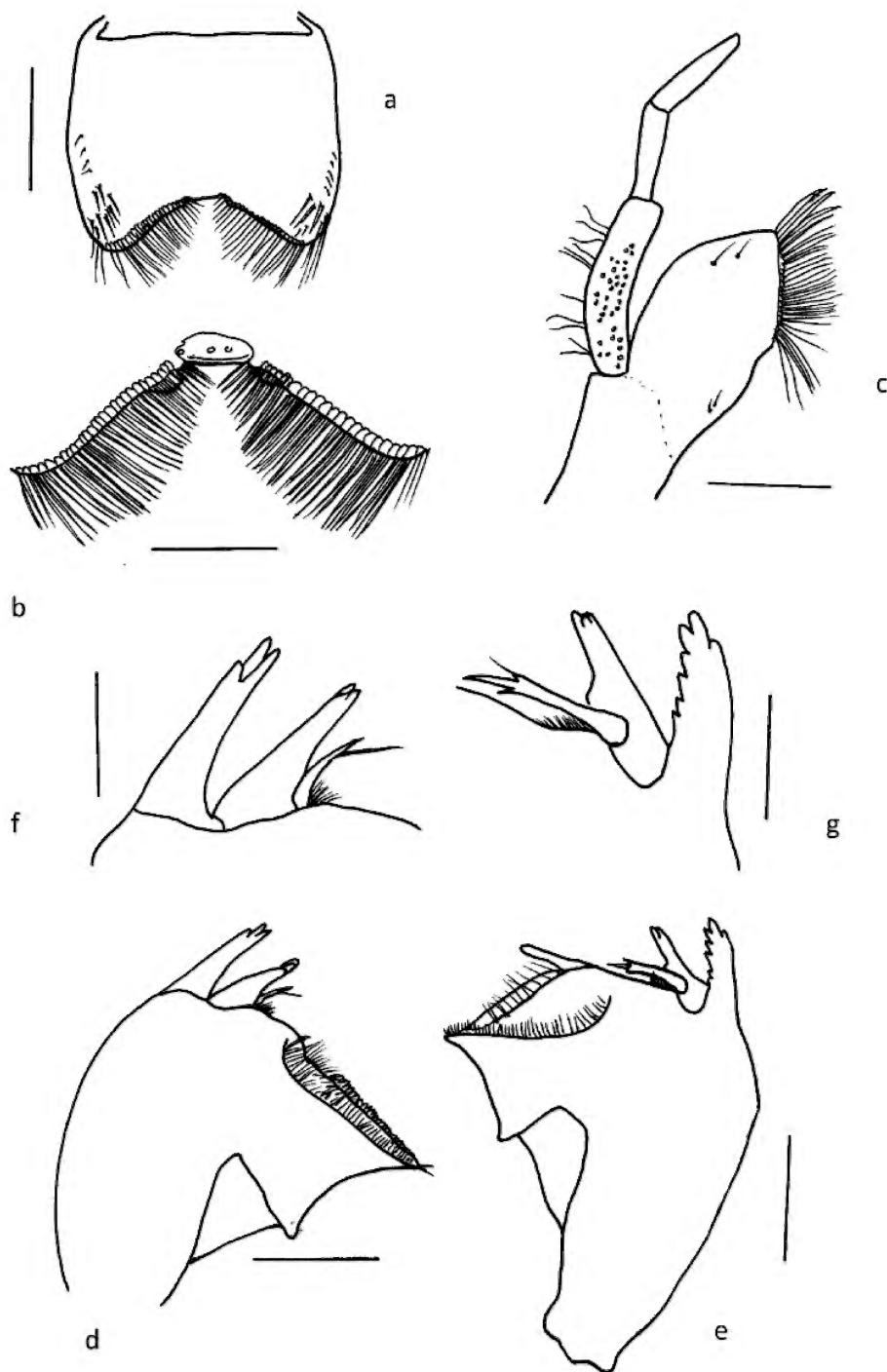


Figure 23. *Skolomystax vulgaris*: a, labrum; b, labrum notch; c, maxilla; d, right mandible; e, left mandible; f, right mandible incisors; g, left mandible incisors. Scale lines: a, c–e = 0.15 mm; b, f, g = 0.07 mm.



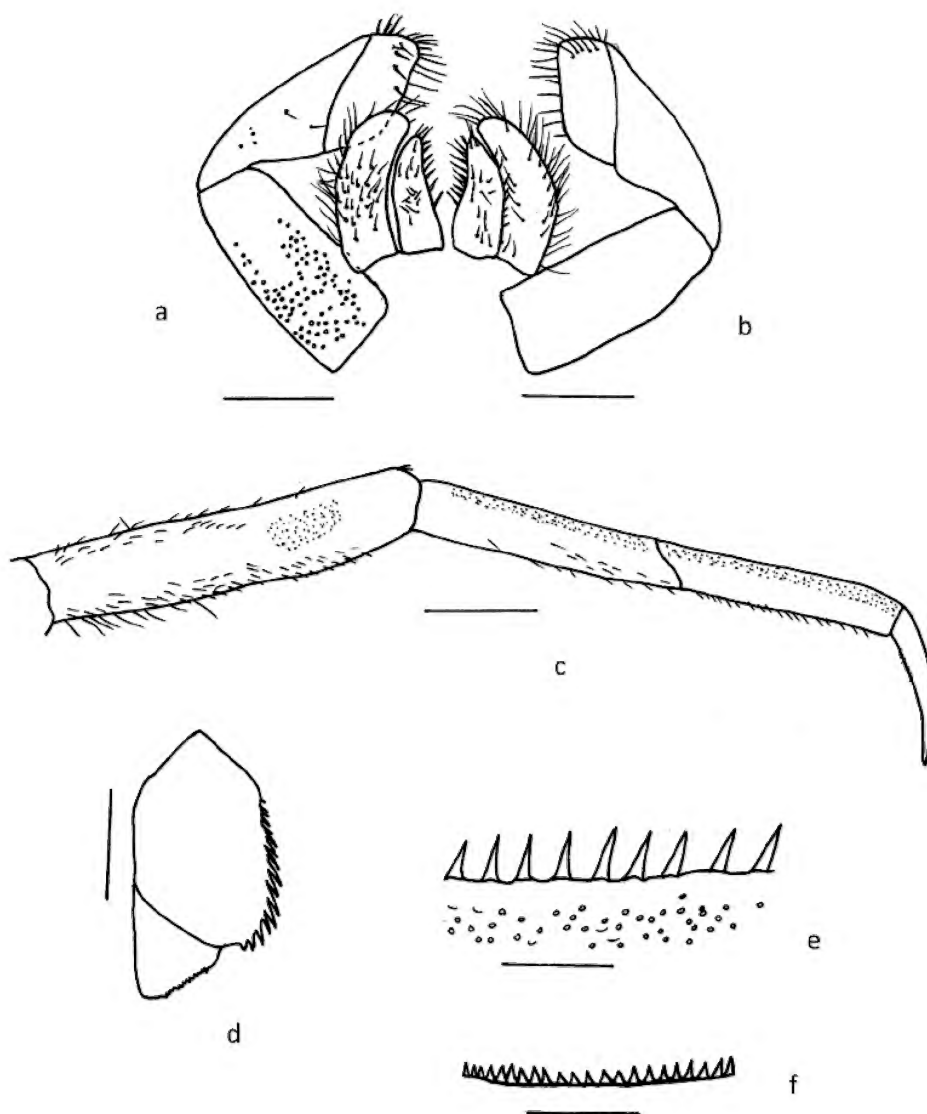


Figure 24. *Skolomystax vulgaris*: a, labium dorsal; b, labium ventral; c, leg; d, paraproct; e, tergite spines; f, sternite spines. Scale lines: a–f = 0.15 mm.

segment II apically expanded and longer on outer margin than inner margin, dorsal surface with oblique row of fine setae distally, ventral surface with scattered fine setae; segment III subrectangular and slightly falcate, with 11–21 long robust and short fine setae on margins, dorsal surface with long robust setae distally, ventral surface with scattered fine setae. Segment ratios, 1.00 (0.28–0.38 mm) : 0.74–1.09 : 0.19–0.25.

*Legs*: foreleg length 2.34–3.18 mm, with segment ratios of 1.00 (0.92–1.35 mm) : 0.54–0.67 : 0.61–0.78 : 0.32–0.43. Fore femur

4.02–5.81 times longer than wide at midpoint and with indistinct subapical dark band; dorsal margin of fore femora with row of 12–23 short sharply pointed robust setae and with subapical setae usually short and blunt (globular); anterior surface with 3–4 scattered rows of sharply pointed robust setae just below dorsal margin, ventral half with numerous sharply pointed robust setae; ventral margin with 10–17 sharply pointed robust setae. Fore tibia outer margin without robust setae, darker band along outer margin, inner margin with 5–17 long pointed robust setae and few scattered hair-like setae. Fore tarsus outer margin

lacking spines, darker along outer margin, inner margin with distinct row of 21–30 long sharply pointed setae and several scattered long robust setae appearing as additional rows, some robust setae may be slightly fimbriate distally. Tarsal claw length 0.48–0.61 times tarsus length, with two similar rows of denticles in basal half. Middle leg (fig. 24c) length 1.71–2.89 mm, with ratios of 1.00 (1.06–1.50 mm) : 0.50–0.67 : 0.51–0.68 : 0.29–0.38. Middle femur 4.58–6.89 times longer than wide at midpoint and with subapical dark band; dorsal margin of middle femora with row of 12–25 short sharply pointed robust setae and with subapical setae usually short and blunt (globular); anterior surface with 3–4 scattered rows of sharply pointed robust setae just below dorsal margin, ventral half with numerous sharply pointed robust setae; ventral margin with 10–29 sharply pointed robust setae. Middle tibia outer margin usually without robust setae but may have a single setule, slightly darker along outer margin, inner margin with 6–19 long pointed robust setae and few scattered hair-like setae. Middle tarsus outer margin lacking spines, slightly darker along outer margin, inner margin with distinct row of 15–27 long sharply pointed setae and several scattered long robust setae appearing as additional rows, some of robust setae may be slightly fimbriate distally. Tarsal claw length 0.53–0.66 times tarsal length, with two similar rows of denticles in basal half. Hind leg length 2.25–3.23 mm, with ratios of 1.0 (1.08–1.48 mm) : 0.51–0.66 : 0.52–0.59 : 0.29–0.39 (femur : tibia : tarsus : claw measured on outer margin). Hind femur 4.31–7.00 times longer than wide at midpoint and with dark band along outer margin; dorsal margin of hind femora with row of 8–27 short sharply pointed robust setae and with subapical setae usually short and blunt (globular); anterior surface with 3–4 scattered rows of sharply pointed robust setae just below dorsal margin, ventral half with numerous sharply pointed robust setae; ventral margin with 2–22 sharply pointed robust setae. Hind tibia outer margin without robust setae, but may have sparse fine hair-like setae, slightly darker along outer margin, inner margin with 16–22 long pointed robust setae and few scattered hair-like setae. Hind tarsus outer margin lacking spines but may have a sparse fine hair-like setae slightly darker along outer margin, inner margin with distinct row of 15–27 long sharply pointed setae and several scattered long robust setae appearing as additional rows, some robust setae may be slightly fimbriate distally. Tarsal claw length 0.56–0.67 times tarsal length, with two similar rows of denticles in basal half.

**Abdomen:** abdominal tergites with a distinct colour pattern (fig. 25k), segments VII, VIII and X light, other segments mostly dark. Abdominal terga I–X with numerous long spines on posterior margins, those on posterior segments 1.83–3.25 times longer than basal width, bases of spines separated by greater than spine width (fig. 24e). Surfaces of terga with pointed scales and scale bases. Sterna IV–IX or V–IX with spines on posterior margin, spine length 1.60–3.14 times width, bases contiguous (fig. 24f). Surfaces of sterna with scale bases. Paraprocts (fig. 24d) with 18–22 marginal spines, surface lacking long fine setae, scale bases sparse. Cerci and terminal filament subequal in size, slightly darkened distally, every other articulation darkly coloured, and inner surfaces with long fine setae nearly to apex.

**Adults:** unknown.

**Etymology:** “Vulgaris” is Latin for “common”.

**Distribution:** Widespread in Vic and NSW.

## Discussion

The absence of robust setae on the outer margins of the tibiae differentiates *S. vulgaris* from *S. elongatus*, *S. paschei* and *S. brevis*. *Skolomystax vulgaris* is most similar to *S. chionotos*, *S. goorudensis*, and *S. tasmaniensis*. The absence of short spines between the long spines on the posterior margins of the terga and shallower labral angle distinguish *S. vulgaris* from *S. goorudensis*, and *S. tasmaniensis* is restricted to Tas and has the inner margin of the left inner incisor rugose, rather than smooth. *Skolomystax vulgaris* differs from *S. chionotos* in having the second maxillary palp shorter than the third.

## *Skolomystax collendus* (Harker, 1957) n.comb.

**Discussion.** We have found no specimens that match the description of the male subimago or nymph described by Harker (1957), and we have been unable to locate the type material. Harker (1957) stated type material was deposited in the British Museum, but it has no record of the types and this material was not deposited in the Australian Museum where Harker placed material from earlier papers. Therefore, we consider this species of uncertain status until collections are made at the type locality. The hindwing illustrated by Harker (1957: 75, fig. 59) shows three unforked longitudinal veins with several crossveins between them and a sharply pointed costal projection that differentiates it from the other adults we have seen. The nymphal description is not sufficiently detailed to be of diagnostic value. It is possible *S. collendus* is conspecific with *S. dyarrii*, as suggested by Webb and Suter (2011), because both are known from the area around Sydney, NSW. Consistent with this is the presence of teeth on the inner margin of the outer incisors of the left mandible and a rugose base of the inner incisors, as illustrated by Harker (1957: 75). In addition, *S. dyarrii* has a short second segment of the maxillary palp and the basal segment is nearly as long as the galealacinia, as noted by Harker (1957: 76) for *S. collendus*. However, the illustration of the left mandible by Harker (1957) shows distinct teeth on the outer margin of the outer incisor, a characteristic we have not observed in any specimens of *Skolomystax*.

## Key to nymphs of *Skolomystax* from Australia

- 1    Legs with spine-like setae on the outer (dorsal) margins of tibiae and tarsi (figs. 3a, 5c, 20g) ..... 2
- 1'   Legs lacking spine-like setae on the outer margin of tibiae and usually on the tarsi, very rarely with one or two present (figs. 7c, 9a, 11f, 13c, 15a, 18d, 22c, 24c) ..... 4
- 2(1)   Dark brown markings on head, mandibles and labrum (figs. 4e, 5d); sternite spines on distal margin of abdominal segments V–IX conical with bases contiguous (fig. 4j; spines on distal margin of tergites long and widely spaced at base (fig. 4i) ..... *Skolomystax brevis*

- 2' Head, mandibles and labrum without distinct brown markings; sternite spines on distal margin of abdominal segments II–IX or III–IX, tergites and sternite spines long with alternating shorter spines (figs. 2f–g, 19f–g) ..... 3
- 3(2) Labrum with notch with margins angled, notch depth >25% of total length (figs. 2a, b); segment I of maxillary palp long, extending to apical third of galealacinia, segments I+II length extends beyond apex of galealacinia (fig. 2c); fore femur with <25 setae on outer margin and <35 on inner margin; mid-tibia with <20 setae on outer margin and <25 setae on inner margin; hind tarsus with <25 spines on the inner margin ..... *Skolomystax elongatus*
- 3' Labrum with notch margins parallel (square notch), notch depth <22% of total length (figs. 19a, b); segment I of maxillary palp long, extending to mid-third of galealacinia, segments I+II length extends to apex of galealacinia (fig. 19c); fore femur with >35 setae on outer margin and >35 on inner margin; mid-tibia with >25 setae on outer margin and >25 setae on inner margin; hind tarsus with >30 spines on the inner margin ..... *Skolomystax paschei*
- 4(1) Body with numerous small dark spots (figs. 18c, 25h–j); canines of maxillae distinctly broader than lacinial setae; left mandible with inner margin of outer incisors with 1–3 small indistinct spines (figs. 14h, 17h); northern Australia ..... 5
- 4' Body lacking numerous small dark spots (figs. 25d–g, 25l–m); canines of maxillae similar to lacinial setae; left mandible with inner margin of outer incisors with 2–5 distinct spines (figs. 6g, 8g, 10g, 12g, 21g, 23g), southern Qld, southeast mainland Australia, and Tas. .... 6
- 5(4) Maxillary palp long, with apex of segment II extending beyond apex of galealacinia (fig. 14c); sternite spines on abdominal segments IV–IX ..... *Skolomystax hawkingi*
- 5' Maxillary palp short, with apex of segment II not extending beyond apex of galealacinia (fig. 17c); sternite spines on abdominal segments V–IX ..... *Skolomystax leichhardti*
- 6(4) Sternite spines on distal margin of abdominal segments VI–IX or VII–IX ..... 7
- 6' Sternite spines on distal margin of abdominal segments IV–IX or V–IX ..... 8
- 7(6) Femora with distinct elongate sub-apical spot; maxillary palp segment II equal in length to segment III (fig. 10c); left mandible with inner margin of outer incisor with two teeth (fig. 10g), sternite spines on distal margin of abdominal segments VI–IX ..... *Skolomystax gippslandicus*
- 7' Femora without distinct sub-apical spot; maxillary palp segment II shorter than segment III (fig. 8c); left mandible with inner margin of outer incisor with four teeth (fig. 8g), sternite spines on abdominal segments VI–IX or VII–IX ..... *Skolomystax dyarri*
- 8(6) Tergite X tinged dark; tergite spines long but with occasional short spines; left mandible with outer incisor with three teeth on inner margin (fig. 12g) ..... *Skolomystax goorudensis*
- 8' Tergite X light; tergite spines all long (figs. 7e, 22e, 24e); left mandible outer incisor with 3–5 teeth on the inner margin (figs. 6g, 21g, 23g) ..... 9
- 9(8) Maxillary palp segment II longer than segment III (fig. 6c) with segment I extending nearly to apex of galealacinia; left mandible with base of inner incisors rugose (fig. 6g); labial notch angle <100° (fig. 6a) ..... *Skolomystax chionotos*
- 9' Maxillary palp segment II shorter than segment III (figs. 21c, 23c) with segment I extending no more than to the apical third of galealacinia; labial notch angle >100° (figs. 21a, 23a) ..... 10
- 10(9) Maxillary palp segment II shorter but almost equal to segment III (fig. 23c); left mandible with base of inner incisors smooth (fig. 23g); Australian mainland ..... *Skolomystax vulgaris*
- 10' Maxillary palp segment II shorter than segment III (fig. 21c); left mandible with base of inner incisors rugose (fig. 21g); endemic to Tasmania ..... *Skolomystax tasmaniensis*

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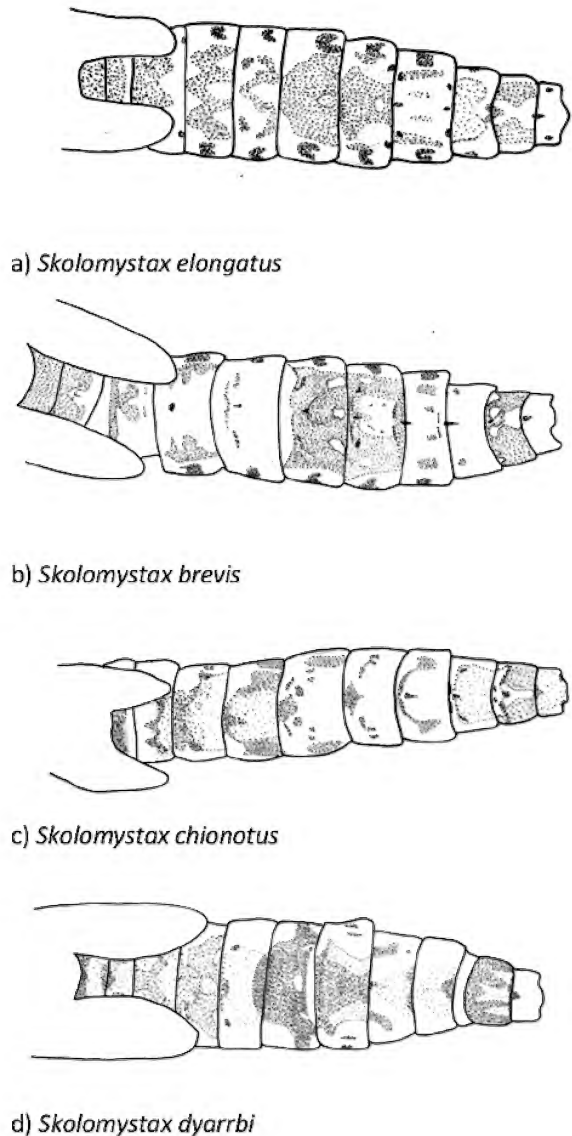


Figure 25. *Skolomystax* spp dorsal colour patterns of nymphs.

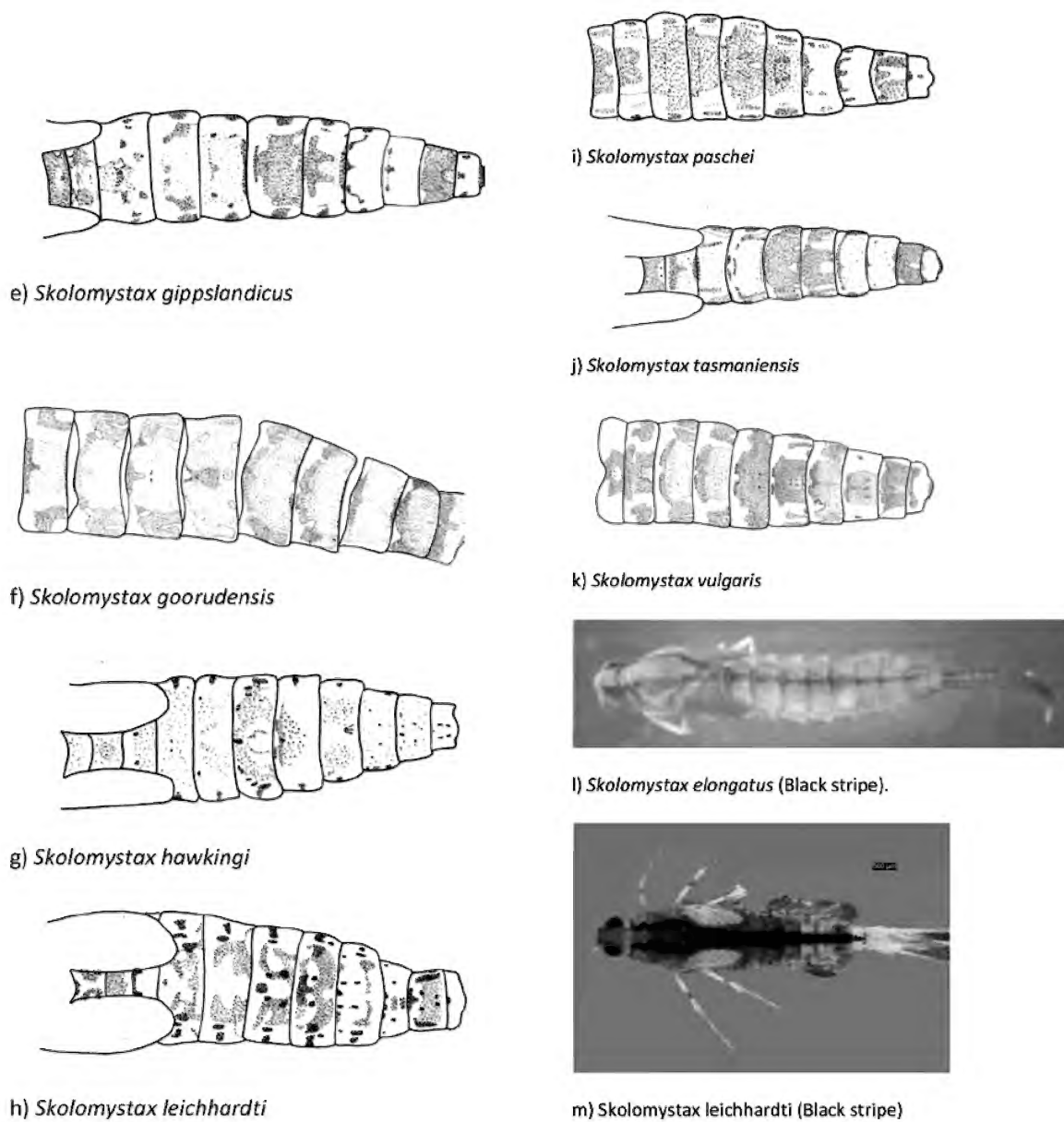


Figure 25 (Continued) *Skolomystax* spp dorsal colour patterns of nymphs.

Supplementary Table 1. Genbank sequence data used as a genetic backbone for the morphological examination of *Skolomystax* species. Genbank accession numbers, type status, specimen voucher code and new species determinations for the sequences (Chakrabarty et al., 2013)

Taxon	Identifier	Type Status	GenBank# (COI)	GenSeq designation	Specimen Voucher Code
<i>Callibaetis</i>	JWA1682		OP709301	genseq-4 COI	JWA1682
<i>Centroptilum luteolum</i>	JWA1860		OP709304	genseq-4 COI	JWA1860
<i>Neocloeon triangulifer</i>	JWA1680		OP709300	genseq-4 COI	JWA1680
<i>Offadens sp1</i>	JWA1146		OP709285	genseq-4 COI	JWA1146
<i>Skolomystax brevis</i>	JWA394	holotype	OP709290	genseq-1 COI	ANIC6-000083
<i>Skolomystax brevis</i>	JWA1303	paratype	OP709295	genseq-2 COI	ANIC6-000086
<i>Skolomystax brevis</i>	JWA1281	paratype	OP709298	genseq-2 COI	ANIC6-000085
<i>Skolomystax chionotos</i>	JWA753	holotype	OP709308	genseq-1 COI	ANIC6-000104
<i>Skolomystax dyarri</i>	JWA1304	holotype	OP709299	genseq-1 COI	ANIC6-000100
<i>Skolomystax dyarri</i>	JWA1983	paratype	OP709309	genseq-2 COI	ANIC6-000101
<i>Skolomystax elongatus</i>	JWA766		OP709292	genseq-3 COI	JWA766
<i>Skolomystax elongatus</i>	JWA1251		OP709297	genseq-3 COI	JWA1251
<i>Skolomystax elongatus</i>	110357		OP709313	genseq-3 COI	110357
<i>Skolomystax gippslandicus</i>	JWA1731	holotype	OP709302	genseq-1 COI	ANIC6-000097
<i>Skolomystax gippslandicus</i>	JWA2883		OP709312	genseq-3 COI	JWA2883
<i>Skolomystax gippslandicus</i>	JWA2884	paratype	JN289957	genseq-2 COI	JWA2884
<i>Skolomystax gippslandicus</i>	JWA2885	paratype	JN289958	genseq-2 COI	JWA2885
<i>Skolomystax hawkingi</i>	JWA1819	paratype	OP709296	genseq-2 COI	ANIC6-000094
<i>Skolomystax hawkingi</i>	JWA750		OP709307	genseq-3 COI	JWA750
<i>Skolomystax leichhardti</i>	JWA2485		OP709305	genseq-3 COI	JWA2485
<i>Skolomystax tasmaniensis</i>	JWA290		OP709287	genseq-3 COI	JWA290
<i>Skolomystax tasmaniensis</i>	JWA343	paratype	OP709288	genseq-2 COI	ANIC6-000113
<i>Skolomystax tasmaniensis</i>	JWA357	holotype	OP709289	genseq-1 COI	ANIC6-000111
<i>Skolomystax tasmaniensis</i>	JWA342	paratype	OP709306	genseq-2 COI	ANIC6-000112
<i>Skolomystax vulgaris</i>	JWA85	holotype	OP709286	genseq-1 COI	ANIC6-000106
<i>Skolomystax vulgaris</i>	JWA637	paratype	OP709291	genseq-2 COI	ANIC6-000108
<i>Skolomystax vulgaris</i>	JWA1233	paratype	OP709293	genseq-2 COI	ANIC6-000107
<i>Skolomystax vulgaris</i>	JWA1234		OP709294	genseq-3 COI	JWA1234
<i>Skolomystax vulgaris</i>	JWA1755	paratype	OP709303	genseq-2 COI	ANIC6-000109
<i>Skolomystax vulgaris</i>	JWA2288		OP709310	genseq-3 COI	JWA2288
<i>Skolomystax vulgaris</i>	JWA2289		OP709311	genseq-3 COI	JWA2289

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## A new species of the water mite genus *Austraturus* K.O. Viets, 1978 from Victoria, Australia (Acari: Aturidae: Notoaturinae)

(<https://zoobank.org/urn:lsid:zoobank.org:pub:0770937E-5AC7-41D4-9923-4BB8CE27522C>)

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### Abstract

Smit, H. and Pešić, V. 2023. A new species of the water mite genus *Austraturus* K.O. Viets, 1978 from Victoria, Australia (Acari: Aturidae: Notoaturinae). *Memoirs of Museum Victoria* 82: 49–53.

A new species of the water mite genus *Austraturus* K.O. Viets (Acari: Aturidae: Notoaturinae) is described, and a list of successfully barcoded Australian water mites is provided.

### Keywords

Systematics, new species, barcoding, COI.

### Introduction

The water mite genus *Austraturus* is an endemic genus for Australia, with 26 species known (Cook, 1986; Smit, 1996, 2007, 2010, 2018, 2021). Most species occur in the northern, eastern and southeastern parts of the country; only two species are found in Western Australia.

Carew et al. (2022) were the first to publish the results of the barcoded water mites of Australia, identifying them to genus level. The senior author of the current paper identified the barcoded Australian water mites of Carew et al. (2022) to species level and slide mounted the material (see Table 1). Table 1 includes only the successfully barcoded specimens; however, several successfully barcoded specimens were lost during the barcoding process so are not included. All material of Table 1 is lodged in the Melbourne Museum, Melbourne. One *Austraturus* specimen from Carew et al.'s (2022) material is a species new to science, and is described in this paper.

### Material and methods

The holotype of the new *Austraturus* species is dissected and slide mounted in Faure's medium. The holotype will be lodged in the Melbourne Museum, Melbourne.

All measurements are given in µm. Photographs of selected structures were taken using a Samsung Galaxy smartphone camera. The following abbreviations are used: Cx-I–IV – first to fourth coxae; I-L-1–6 – first to sixth segments of first leg; IV-L-4-6 – fourth to sixth segments of fourth leg; NMV – Melbourne Museum; P-1– P-5 – palp segments 1 to 5.

### Systematics

#### Family Aturidae Thor, 1900

Subfamily Notoaturinae Besch, 1964

Genus *Austraturus* K.O. Viets, 1978

Table 1. List of successfully barcoded Australian water mites. For information on data of locations and collecting data, see [https://www.boldsystems.org/index.php/Public\\_BINSearch?searchtype=records](https://www.boldsystems.org/index.php/Public_BINSearch?searchtype=records)

Family	Species	BOLD accession number
Limnocharidae	<i>Austrolimnochares womerslyi</i> (Lundblad, 1952)	AFWM005-21
	<i>A. womerslyi</i> (Lundblad, 1952)	AFWM095-21
Hydryphantidae	<i>Diplodontus haliki</i> Lundblad, 1947	AFWM105-21
Aturidae	<i>Austraturus carewae</i> sp. nov.	AFWM084-21

Hygrobatidae	<i>Aspidiobates aethes</i> Harvey and Cook, 1988	AFWM078-21
	<i>Australiobates rudagus</i> Cook, 1988	AFWM081-21
	<i>Australiobates mutatus</i> K.O. Viets, 1978	AFWM014-21
	<i>Australiobates linderi</i> Lundblad, 1941	AFWM103-21
	<i>A. linderi</i> Lundblad, 1941	AFWM066-21
	<i>Australorivacarus multiscutatus</i> K.O. Viets, 1978	AFWM113-21
	<i>Caenobates acheronius</i> K.O. Viets, 1978	AFWM060-21
	<i>C. acheronius</i> K.O. Viets, 1978	AFWM054-21
	<i>C. acheronius</i> K.O. Viets, 1978	AFWM056-21
	<i>C. acheronius</i> K.O. Viets, 1978	AFWM059-21
	<i>C. acheronius</i> K.O. Viets, 1978	AFWM080-21
	<i>C. acheronius</i> K.O. Viets, 1978	AFWM082-21
	<i>Procorticacarus angulicoxalis</i> (K.O. Viets, 1978)	AFWM027-21
	<i>Procorticacarus victorianus</i> (K.O. Viets, 1978)	AFWM092-21
	<i>P. victorianus</i> (K.O. Viets, 1978)	AFWM114-21
	<i>Rhynchaustrobates victorianus</i> Smit, 2015	AFWM091-21
	<i>R. victorianus</i> Smit, 2015	AFWM085-21
	<i>R. victorianus</i> Smit, 2015	AFWM086-21
Limnesiidae	<i>Limnesia corpulenta</i> K.O. Viets, 1984	AFWM012-21
	<i>Limnesia solida</i> Lundblad, 1947	AFWM107-21
	<i>L. solida</i> Lundblad, 1947	AFWM106-21
	<i>L. solida</i> Lundblad, 1947	AFWM109-21
	<i>L. solida</i> Lundblad, 1947	AFWM110-21
	<i>Limnesia otruma</i> Cook, 1986	AFWM089-21
	<i>Limnesia tasmanica</i> (Lundblad, 1941)	AFWM046-21
	<i>L. tasmanica</i> (Lundblad, 1941)	AFWM044-21
	<i>L. tasmanica</i> (Lundblad, 1941)	AFWM048-21
Oxidae	<i>Oxus tenuipes</i> Lundblad, 1947	AFWM043-21
	<i>O. tenuipes</i> Lundblad, 1947	AFWM041-21
	<i>O. tenuipes</i> Lundblad, 1947	AFWM042-21
	<i>O. tenuipes</i> Lundblad, 1947	AFWM045-21
	<i>O. tenuipes</i> Lundblad, 1947	AFWM047-21
Pionidae	<i>Acercella falcipes</i> Lundblad, 1941	AFWM116-21
	<i>Piona cumberlandensis</i> (Rainbow, 1906)	AFWM104-21
Unionicolidae	<i>Neumania nodosa</i> (Daday, 1898)	AFWM049-21

### *Austraturus carewae* sp. nov. (figs. 1–2)

Zoobank: <https://zoobank.org/urn:lsid:zoobank.org:act:F18549BB-864A-4461-936A-233948312903>

**Material examined.** Holotype male (NMV), McCrae Creek, Victoria, Australia, 37.81729219 S, 145.5059157 E, 14 November 2018, leg. C. Kellar and K. Stevenson (sequenced; BOLD: AFWM084-21).

**Diagnosis.** A pair of enlarged setae on the dorsal posteromedial plate placed close and laterally to the anterior pair of glandularia, posterior margin of posteromedial plate with a rounded extension; tips of Cx-I bluntly pointed; P-2 with three stout denticles; IV-L-4 ventral margin with a rounded extension in the proximal part, bearing six setae of which the anterior is long and stout.



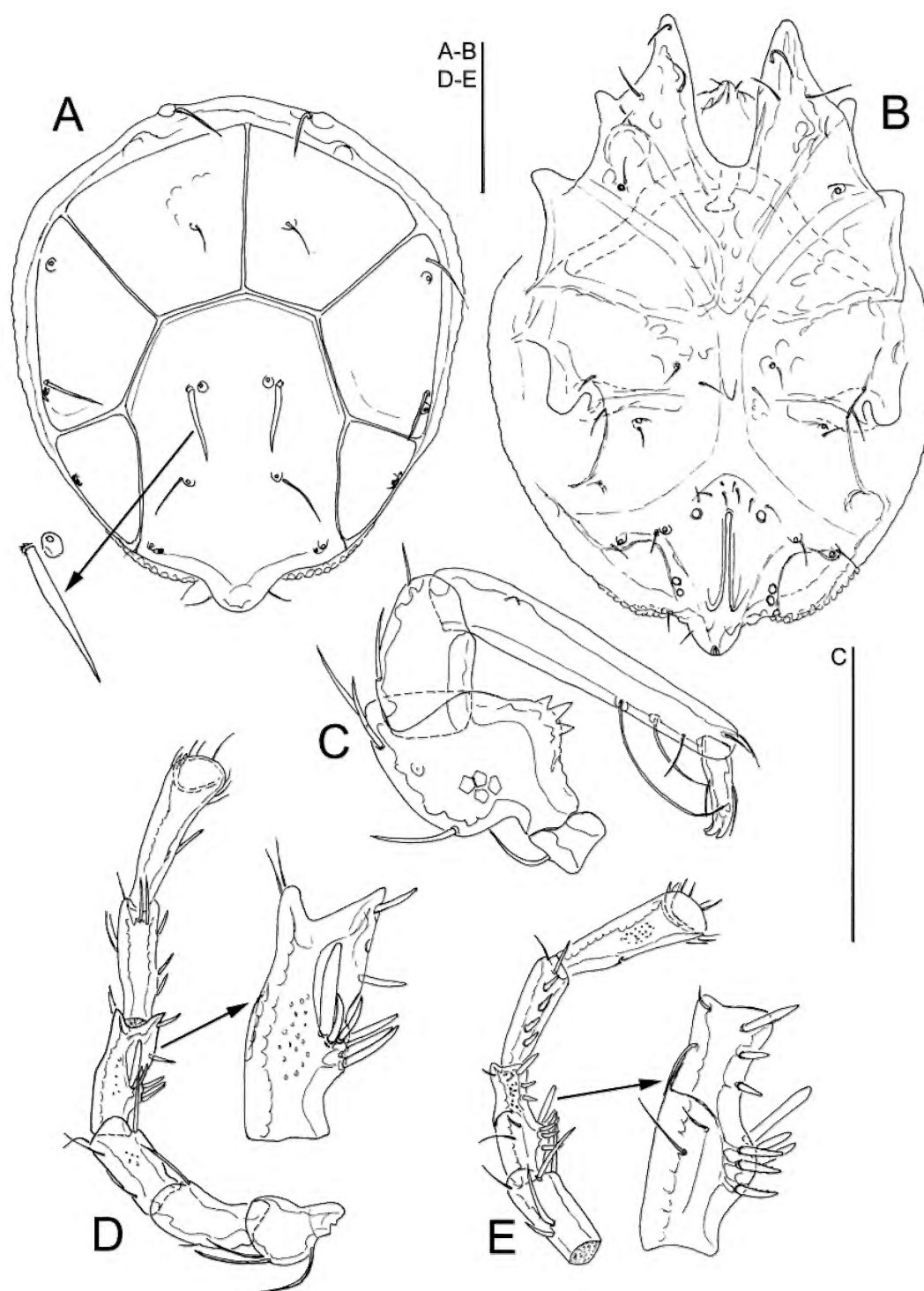


Figure 1. *Austraturus carewae* sp. nov. ♂ holotype: A, idiosoma, dorsal view; B, idiosoma, ventral view; C, palp; D, right IV-leg (inset: IV-L-4, 2x enlarged); E, left IV-L-3-6 (inset: IV-L-4, 2x enlarged). Scale bars = 100 µm.

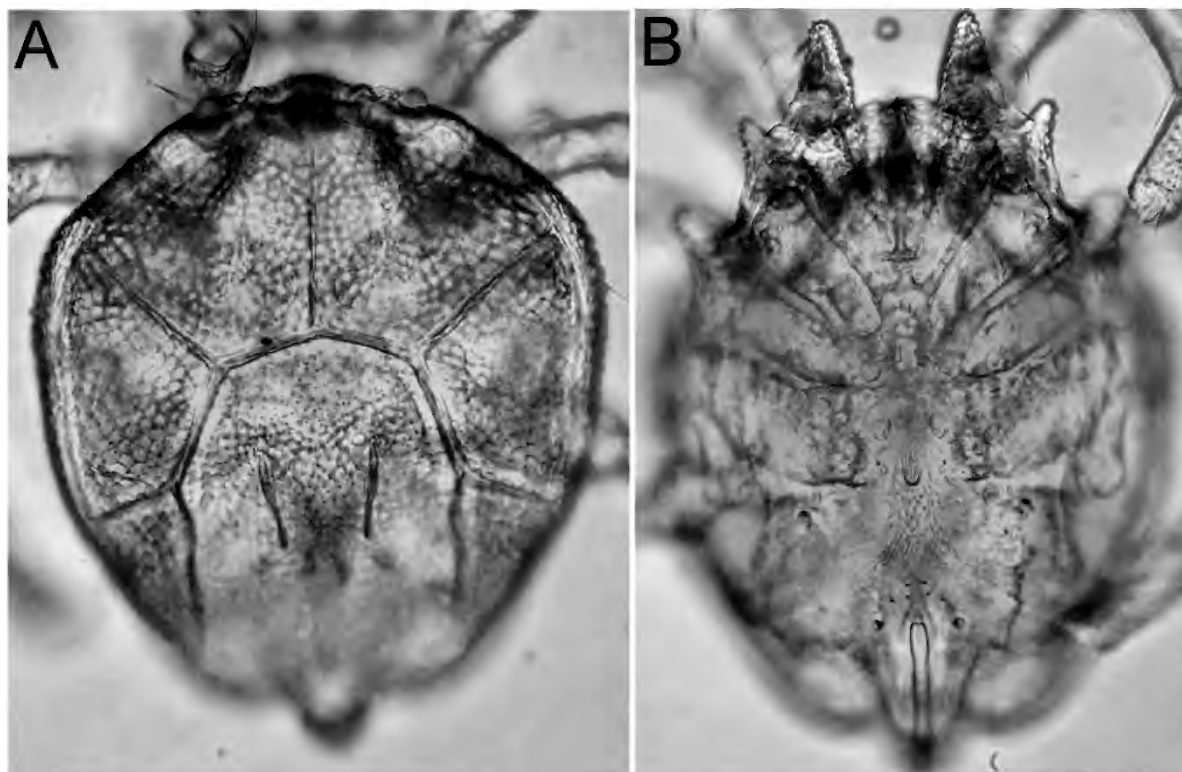


Figure 2. Photographs of *Austraturus carewae* sp. nov. ♂ holotype: A, idiosoma, dorsal view; B, idiosoma, ventral view.

**Description.** Male: idiosoma dorsally 347 long and 305 wide, ventrally 430 long. Ventral and dorsal shield with a colour pattern as illustrated in fig. 2A–B. Frontal margin rounded; dorsum with paired anteromedial plates, an unpaired posteromedial plate and two paired lateral plates. Anterolateral dorsal platelets with two pairs of glandularia, posterolateral dorsal plates with one pair of glandularia without enlarged setae. Posteromedial plate with only the anterior pair of glandularia with enlarged setae; posterior margin with a somewhat broad and rounded extension. Gnathosomal bay 101 long, tips of Cx-I bluntly pointed, coxae fused to ventral shield, suture lines lightly visible. Glandularia of Cx-IV closer to posterior margin than to anterior margin. Near anterior end of gonopore two pairs of glandularia, the anterior pair closer to each other than posterior pair. Genital field with numerous acetabula, poorly visible in ventral view. Gonopore narrow, 72 long. Palp: dorsal length/height, ratio: P-1, 20/22, 0.9; P-2, 70/64, 1.1; P-3, 55/32, 1.73; P-4, 117/21, 5.5; P-5, 31/10, 3.1; P-2/P-4 length ratio 0.6. P-2 with three stout ventral denticles, P-4 slender (fig. 1C).

Legs: dorsal length of I-L-2-5: 48, 58, 81, 81; dorsal length of IV-L-1-6: 59, 77, 72, 84, 83, 108. IV-L-4 ventral margin with a rounded extension in the proximal part, bearing six setae of which the anterior seta is longer and stouter (Figures 1D–E), dorsal sector concave, here with three setae; IV-L-5 ventrally with four setae.

**Etymology.** Named after Melissa E. Carew, University of Melbourne.

**Discussion.** The new species is most similar to *Austraturus sagittalis* Smit, 2018. The latter species, known from a male collected in a small creek in Queensland, differs from the new species in a broad arrow-shaped posterior extension of the posteromedial plate. While the new species' anterior pair of glandularia of the posteromedial plate are more distanced from the associated setae, the latter's setae are comparatively more slender. Other differences can be found in the shape of IV-L-4 and -5 (IV-L-4 ventrally with eight setae and an anteroventral extension, and more medially three setae of which the most anterior seta is the longest; IV-L-5 ventrally with six setae). Moreover, in *A. sagittalis* the tips of Cx-I are truncated and P-2 possesses only two stout ventral denticles (see Smit 2018). *Austraturus projectus* Cook, 1986, a species known from Tasmania, is somewhat similar in the shape of the posteromedial dorsal plate and its setae, but the anteromedial dorsal plates are projecting, the tips of Cx-I are truncated and P-2 has two rather stout, short ventral setae.

#### Acknowledgements

We are indebted to Melissa Carew for putting the material at our disposal.

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DOI <https://doi.org/10.24199/j.mmv.2023.82.03>

## A new species of *Arenallianassa* (Decapoda: Axiidea: Callianassidae) from hydrothermal vents with notes on its ecology and a redescription of *Arenallianassa arenosa* (Poore, 1975)

(<http://zoobank.org/urn:lsid:zoobank.org:pub:542B22BB-6068-4831-AFBB-59880DF3DE0B>)

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### Abstract

Schnabel, K.E., Rowden, A.A., and Poore, G.C.B. 2023. A new species of *Arenallianassa* (Decapoda: Axiidea: Callianassidae) from hydrothermal vents with notes on its ecology and a redescription of *Arenallianassa arenosa* (Poore, 1975). *Memoirs of Museum Victoria* 82: 55–69.

The hitherto monotypic genus *Arenallianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 is revised following the discovery of a new species, *Arenallianassa katrinae* sp. nov. from New Zealand and Tonga. The original description of the type species *Arenallianassa arenosa* (Poore, 1975) is augmented. The new species has been found in localised high abundance in the vicinity of shallow (111–181 m depth) hydrothermal vents at each end of the Kermadec–Tonga Volcanic Arc system. This brings the number of callianassoids in New Zealand to six.

### Keywords

Ghost shrimp, chemosynthetic, integrative taxonomy, Kermadec–Tonga Volcanic Arc, DNA barcoding, COI, 16S

### Introduction

Recent morphological and molecular reviews of the ghost shrimp family Callianassidae Dana, 1852 established 12 new genera, increasing the currently recognised number of genera to 27 (Poore et al., 2019; Robles et al., 2020). The monotypic genus *Arenallianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 was established for *Callianassa arenosa* Poore, 1975 based on its phylogenetically remote placement within the callianassid gene tree. The species was considered morphologically and genetically most closely related to *Paratrypaea* Komai and Tachikawa, 2008 and *Filhollianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019, separated from these genera by differences in the major cheliped, uropodal endopod and telson.

Since these revisionary studies, an undescribed species belonging to *Arenallianassa* has been collected from two disjunct localities along the Kermadec–Tonga Volcanic Arc system. Interestingly, the new species was in both cases collected around shallow (~100–200 m depth) hydrothermal vents, an

environment very different from its congener, *A. arenosa*, which is abundant in the intertidal and shallow waters of eastern Australia (Poore, 1975; Butler et al. 2009).

This paper redescrives the type species *A. arenosa* and describes the new species from New Zealand. Anecdotal evidence indicates that the new species occurs in localised high abundances.

### Material and methods

**Morphological examination.** Size is expressed as carapace length (cl) or total length (tl), including rostrum, in mm. Measurements for the holotype are indicated in square brackets. Material examined is deposited in Museums Victoria, Melbourne (NMV), Northern Territory Museum and Art Gallery, Darwin (NTMAG), and the National Institute of Water and Atmospheric Research Invertebrate Collection, Wellington (NIWA).

**Molecular taxonomy.** DNA was extracted from a pleopod and using the DNeasy Blood & Tissue Kit (QIAGEN, Germantown, MD, USA) following the manufacturer's protocols. A partial

Table 1. Pairwise percentage genetic distances for aligned partial 16S rRNA gene (432 bp) between *Arenallianassa katrinae* sp. nov. (grey columns) and published GenBank sequences for a selection of Callianassidae previously presented by Porter et al. (2005) and Robles et al. (2009, 2020).

Species	Study	Accession Number	NIWA 157710	NIWA 157716	NIWA 32198	DQ079705	EU874945n	MN237673.1	EU874949.1	MN237723.1	EU882913.1	MN237847	EU882950.1	EU882947.1
<i>A. katrinae</i> sp. nov. paratype	this study	OP178649	–											
<i>A. katrinae</i> sp. nov.	this study	OP178651	0.002	–										
<i>A. katrinae</i> sp. nov.	this study	OP178650	0.015	0.017	–									
<i>A. arenosa</i> (Poore, 1975)	Porter et al. 2005	DQ079705	0.069	0.071	0.074	–								
<i>A. arenosa</i> (Poore, 1975)	Robles et al. 2009	EU874945	0.064	0.066	0.069	0.007	–							
<i>Filhollianassa ceramica</i> (Fulton and Grant, 1906)	Robles et al. 2020	MN237673.1	0.076	0.078	0.081	0.073	0.069	–						
<i>Filhollianassa filholi</i> (A. Milne-Edwards, 1879)	Robles et al. 2009	EU874949.1	0.069	0.071	0.074	0.066	0.062	0.048	–					
<i>Paratrypaea bouvieri</i> (Nobili, 1904)	Robles et al. 2009	MN237723.1	0.085	0.087	0.09	0.093	0.089	0.101	0.094	–				
<i>P. bouvieri</i> (Nobili, 1904)	Robles et al. 2009	EU882913.1	0.084	0.086	0.089	0.092	0.087	0.1	0.093	0.06	–			
<i>Trypaea australiensis</i> Dana, 1852	Robles et al. 2020	MN237847	0.126	0.128	0.131	0.123	0.118	0.123	0.116	0.15	0.149	–		
<i>Neotrypaea gigas</i> (Dana, 1852)	Robles et al. 2009	EU882950.1	0.153	0.155	0.158	0.15	0.146	0.15	0.143	0.178	0.176	0.15	–	
<i>Neotrypaea californiensis</i> (Dana, 1854)	Robles et al. 2009	EU882947.1	0.153	0.155	0.158	0.15	0.146	0.15	0.143	0.178	0.177	0.15	0.025	–

sequence of the mitochondrial cytochrome c oxidase I (COI) gene was amplified using the universal primer pairs LCO1490/HCO2198 (Folmer et al., 1994); a partial sequence of the mitochondrial 16S rRNA gene was amplified using primers 16S-arL/brH (Palumbi and Benzie, 1991) or 16S-SF (Tsang et al., 2014)/16S-1472 (Crandall and Fitzpatrick, 1996). The polymerase chain reaction (PCR) was conducted with MyTaq™ HS DNA Polymerase (Meridian Bioscience, www.meridianbioscience.com) with a protocol as follows: the reactions were conducted in a total volume of 25 µL and processed with an initial denaturation step (95°C, 1 min), followed by 35 cycles of denaturation (95°C, 20 s), annealing (48°C, 25 s) and extension (72°C, 20 s), with a final extension of 5 min at 72°C. PCR products were assessed by agarose gel electrophoresis, cleaned using ExoSAP-IT reagent (USB, Cleveland, Ohio, USA) and commercially sequenced (Macrogen Inc., Seoul, Korea) with the same primers used for the PCR. Sequences were checked for potential contamination using the Basic Local Alignment Search Tool through GenBank. Newly generated sequences were checked and edited and aligned with reference sequences available on GenBank using Geneious (v 2021.1.1) (<http://www.geneious.com>; Kearse et al., 2012). The default Geneious Tree Builder function parameters were applied to calculate the percentage identity and patristic distance matrix (Tamura-Nei distance mode, neighbour-joining tree build method, outgroup not specified). A bootstrap consensus tree was generated using a random seed, 1,000 replicates and a 50% support threshold. Sequences are deposited on GenBank under accession numbers OP174573–

OP174574 (COI) and OP178649–OP178651 (16S) and in BOLD under DECENZ388-22–DECENZ389-22 for COI.

### Molecular taxonomy results

Sequences were successfully generated for the 16S (452–527 bp) and COI (652–657 bp) genes and cover at least one sample for *A. katrinae* sp. nov. from the type locality in the Bay of Plenty, New Zealand (NIWA 157710, 157716) and Volcano 1, Tonga (NIWA 32198). Qi Kou (Chinese Academy of Sciences) kindly shared some sequence information for the latter specimen. Reference sequences for COI are not available on GenBank for most callianassids, but comparing sequences obtained for specimens of *A. katrinae* revealed significant intraspecific divergences (3.2%) between the southern and the northern populations, pointing to a level of genetic isolation (compare sequences deposited on GenBank and BOLD). In the absence of further material from Tonga, this so far represents cryptic diversity yet to be resolved.

Several gene sequences are available on GenBank for *A. arenosa*: Porter et al. (2005) published sequences for 16S, 18S, 28S and H3; Robles et al. (2020) included 16S, 18S, 12S and H3 in their study. One sequence for 16S (AY583895) published by Ahyong and O'Meally (2004) includes ambiguous nucleotides and significant sequence divergence from those reported in the earlier two studies. This sequence is not considered *A. arenosa* s.s. here and should be revisited.

A global 16S alignment of 432 base pairs was assembled for 12 sequences covering eight species of callianassids,

which Robles et al. (2020) showed to be closely related (Table 1, fig. 1). Two sequences for *A. katrinae* sp. nov. from the type locality are near-identical (p-distance: 0.002), while the single specimen from Tonga (NIWA 32198) resolved a p-distance of 0.015–0.017. The most similar sequences represent *A. arenosa* (p-distances: 0.064–0.074) but sequences representing species of *Filhollianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 and *Paratrypaea* Komai and Tachikawa, 2008 show similar divergence (p-distances: 0.069–0.090).

The multi-gene analysis presented for 123 species of Callianassoidea by Robles et al. (2020: figs 1, 3) found *Arenallianassa* as a monotypic taxon placed between two clades, one representing three species of *Paratrypaea* and the other, two species of *Filhollianassa*. With the addition of *A. katrinae*, albeit with the consideration that this analysis only covers a single gene (16S), the monotypy of *Arenallianassa* is

not maintained in a strict consensus tree (fig. 1), even if more sequences of species of (e.g.) *Paratrypaea* are added (not shown). Poore et al. (2019) highlighted the morphological affinities between these genera and proposed fixed morphological differences to support the generic delineation: *Paratrypaea* species have dense setation on the dactylus of the major cheliped and lack the prominent meral hook on the major cheliped; *Filhollianassa* species have a strongly domed anterior carapace and asymmetrical, angular uropodal endopod, the latter proposed as diagnostic difference from the ovoid shape shared by *Arenallianassa* and *Paratrypaea*. These morphological characters are upheld with the addition of *A. katrinae*. While the sequence divergence is marginally closer between the two species of *Arenallianassa*, it is clear that the systematic delineation between these closely related taxa needs further attention.

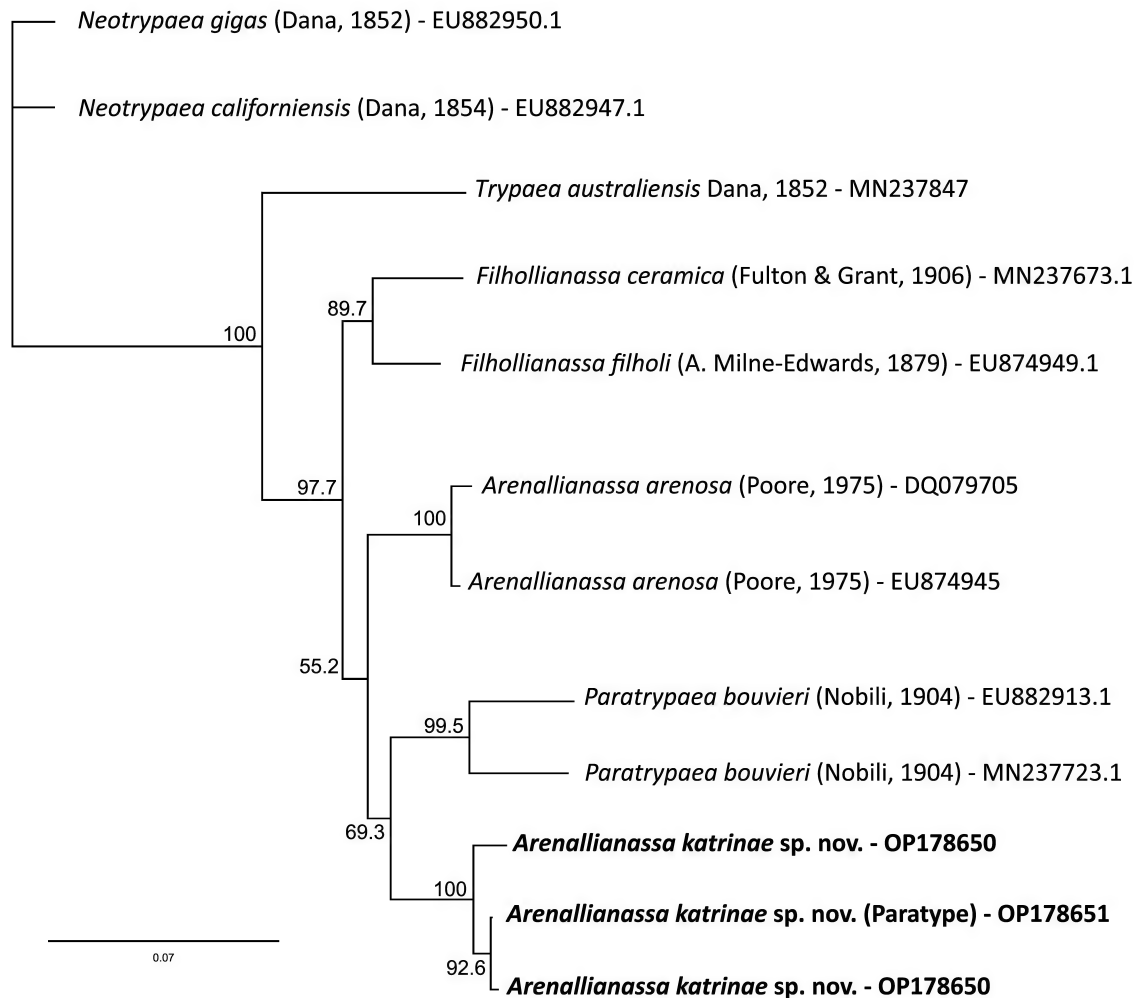


Figure 1. Neighbour-joining consensus tree inferred from the 16S rRNA gene sequences for eight species of Callianassidae. Genbank Accession numbers are appended. Consensus support (%) based on 1000 bootstrap replicates is shown for each node. Scale indicates patristic distances.

## Systematics

### Family Callianassidae Dana, 1852

#### *Arenallianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019

*Arenallianassa* Poore et al., 2019: 91.—Robles et al., 2020: 118, 128, figs 1, 3, 6, 8.

**Diagnosis.** Rostrum obtusely triangular, flat, not reaching cornea. Pleomere 1 tergite with weak transverse ridge. Maxilliped 3 merus wider at ischium-merus suture than long. Male major cheliped merus with prominent truncate or oval hook armed with serrations along lower margin, excavate laterally at base; carpus and propodus flattened, upper and lower margins carinate, blade-like, submarginal mesial face especially of carpus deeply concave; propodus distal margin with deep notch at base of fixed finger. Pereopod 3 propodus rectangular or oval, with broadly rounded free proximal lobe. Male pleopod 2 absent. Uropodal endopod ovoid, longer than wide, anterior margin straight or slightly convex, posterodistal margin evenly convex, with few facial distal spiniform setae; exopod distal margin clearly differentiated from anterior margin, anterodistal corner right-angled. Telson lateral margins convex, subparallel or tapering distally (amended from Poore et al. 2019).

**Remarks.** The genus is diagnosed by the combination of a blade-like meral hook with serrate margins on the major cheliped of both sexes, an ovoid uropodal endopod, little longer than wide, and a telson that is about as wide as long with rounded posterolateral corners (Poore et al., 2019). With the addition of *A. katrinae* sp. nov. the diagnosis is adjusted to consider the different shapes of the pereopod 3 propodus, the distribution of spiniform setae on the uropodal endopod and the difference in the shape of the telson.

Poore's (1975) and (2004) illustrations of *A. arenosa* were basic but enabled him to distinguish the species from other Australian callianassid species. Subsequent observations presented in the supplementary description and figures below show the setae on the telson and uropod, notably the distal transverse row of short spiniform setae on the face of the uropodal endopod, a feature in one form or another shown by Poore et al. (2019) and Robles et al. (2020) to be shared with *Filhollianassa*, *Notiax* Manning and Felder, 1991, *Paratrypaea*, *Trypaea* Dana, 1852 and *Tastrypaea* Poore, Dworschak, Robles, Mantelatto and Felder, 2019.

#### *Arenallianassa arenosa* (Poore, 1975)

Figures 2, 3

*Callianassa arenosa* Poore, 1975: 197–201, figs 1, 2.—Poore and Griffin, 1979: 250, figs. 15–17.—Sakai, 1988: 57.—Sakai, 1999: 39.—Sakai, 2005: 73.

*Biffarius arenosa*.—Tudge et al., 2000: 142.

*Biffarius arenosus*.—Boon et al., 1997: 503–511 (diet).—Bird et al., 1999: 523–532 (sediment transport).—Bird and Poore, 1999: 77–87 (burrow morphology).—Davie, 2002: 457.—O'Hara, 2002: 680.—Poore, 2004: 181, fig. 49b, d, pl. 12a.—Butler et al., 2009: 43–59 (population biology).

*Trypaea arenosa*.—Sakai, 2011: 391.

*Arenallianassa arenosa*.—Poore et al., 2019: 91, 136, 142.—Robles et al., 2020: figs 1, 3, 6.

**Material illustrated.** **Australia**, Victoria, Tooradin, 38.22° S, 145.37° E, NMV J16708 (male, cl 6.9 mm). Cannons Creek, 38.25° S, 145.32° E, NMV J16670 (female, cl 7.3 mm). Sandringham, 37.5° S, 144.99° E; NMV J31887 (male, not measured). Queensland, Conway Beach, Prosperine, 20.48° S, 148.75° E; NMV J16726 (male, cl 5.1 mm). Northern Territory, Gove, 12° 12' S, 136° 43' E; NTMAG Cr009860 (female, cl 5.3 mm, with Bopyridae in branchial cavity).

**Types.** Australia, Victoria, Port Phillip Bay, 3.5 km off Seaford, 13 m, sandy sediment, 8 Sep 1971 (PPBES station 951). Holotype: NMV J271, female, tl 24 mm. Paratypes: NMV J272, male, tl 22 mm; NMV J273, 10 specimens.

**Diagnosis.** Male major cheliped merus lower margin with strong proximal truncate tooth, its apex directed distally, margins serrate, plus low denticulate convex blade beyond midpoint. Minor cheliped merus lower margin with spine at midpoint. Pereopod 3 propodus oval. Telson with convex parallel lateral margins.

**Supplementary description.** Carapace 0.24 total length; with distinct linea thalassinica, with defined dorsal oval marked posteriorly by shallow transverse cervical groove (at 0.8 cl) extending anteroventrally to each side above linea thalassinica as shallow groove; frontal margin scarcely oblique, anterolateral lobe obsolete. Rostrum convex in lateral view, broadly triangular, reaching halfway to cornea. Pleonites 1 and 2 together as long as carapace; ratio of lengths of pleonites 2–6 – 1 : 0.8 : 0.7 : 1 : 1.

Antennular peduncle 0.5 times carapace length, article 3 2.3 times as long as article 2, with ventrolateral row of long setae. Antennal peduncle almost as long as antennular peduncle; article 5 0.75 times as long as article 4; scaphocerite semicircular. Maxilliped 3 ischium 1.2 times as long as wide, dilating distally; crista dentata curved, of about 15 sharp spines, not overlapping ischium-merus suture; merus semicircular, 1.8 times as wide as long, distal margin curved beyond base of carpus; propodus 1.8 times as long as wide, flexor margin almost straight; dactylus with convex extensor margin, flexor margin with dense setal brush over distal half.

Pereopods 1 (chelipeds) unequal, dissimilar, sexually dimorphic. Male major cheliped carpus-palm (fingers of chelae not included) 1.6 times carapace length; ischium slender, lower (flexor) margin with 2 proximal denticles; merus body twice as long as wide, upper margin with 5 proximal tubercles, lower margin with strong proximal truncate tooth (meral hook), its apex directed distally, margins serrate, plus low denticulate convex blade beyond midpoint, lateral face with deep well-defined excavation at base of tooth; carpus as wide as long, upper and lower margins carinate, rolled mesially; propodus upper margin 1.3 times as long as carpus, 1.1 times as long as greatest width, lower margin of palm carinate; palm distomesial margin with denticulate tubercle at base of fixed finger, strongly excavate between tubercle and fixed finger and mesially; fixed finger 0.4 length of lower margin, almost conical; dactylus 0.75 as long as upper margin of palm, cutting edge with blunt tooth in proximal third, another near midpoint, with acute reflexed tip. Minor cheliped carpus-palm about as long as carapace; palm 0.3 times width of major; ischium narrow, unarmed, longer than merus; merus twice as long as wide, lower margin

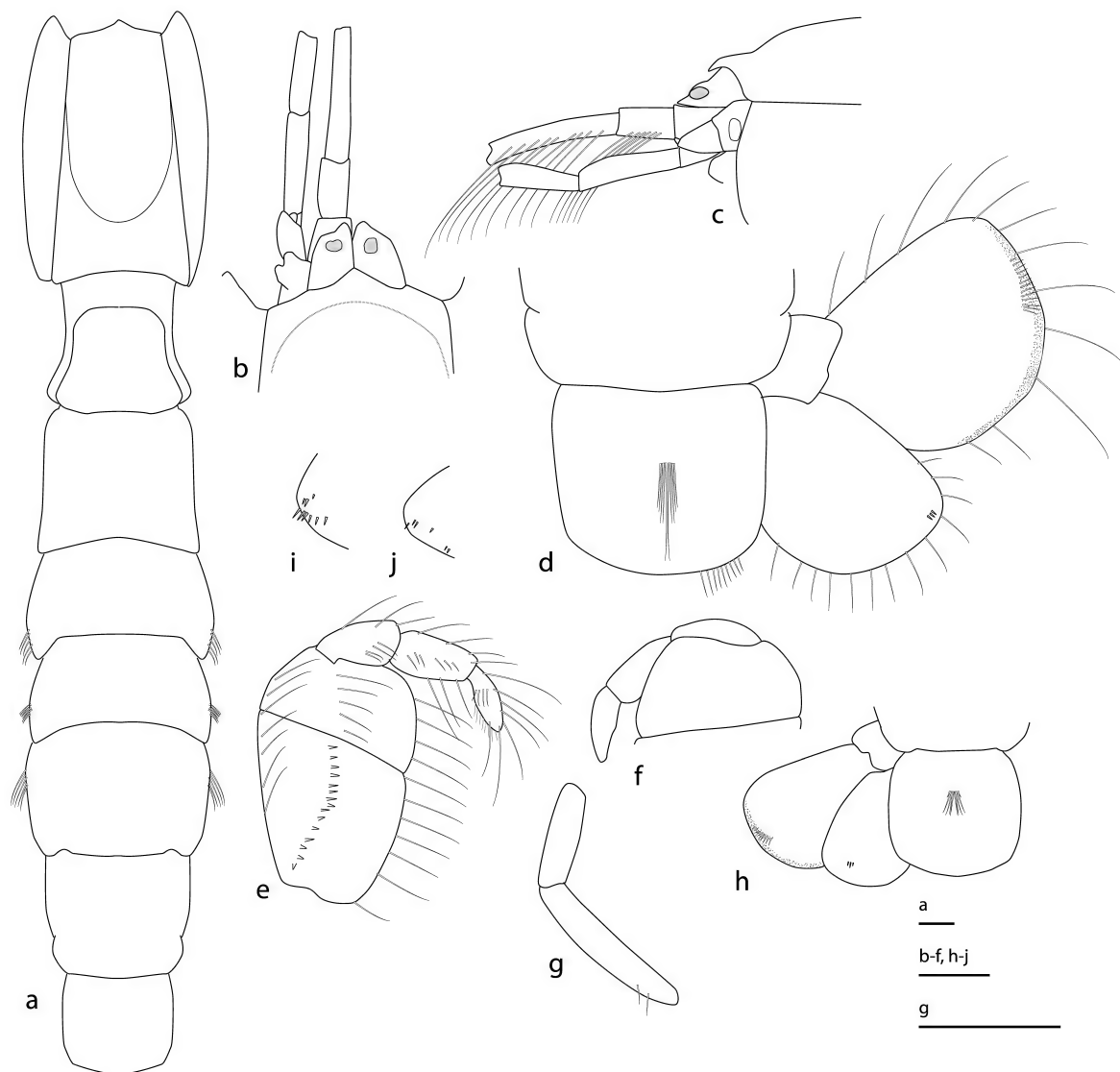


Figure 2. *Arenallianassa arenosa* (Poore, 1975). NMV J16708 (male, cl 6.9 mm): a, carapace, pleon, telson, dorsal view; b, c, anterior carapace, eyestalk, antennule, antenna, dorsal view (only left appendages shown in b); d, telson, right uropod, dorsal view; e, maxilliped 3, mesial view; f, same, distal articles, lateral view; g, pleopod 1, lateral view. NTMAG Cr009860 (female, cl 5.3 mm): h, telson, left uropod, dorsal view. NMV J31887 (male); i, left uropod, anterodistal angle of endopod. NMV J16726 (male, cl 5.1 mm); j, left uropod, anterodistal angle of endopod. Scale bars = 1 mm.

with spine at midpoint; carpus 1.5 times as long as merus, 2.3 times as long as wide, parallel-sided over distal half; palm upper margin 0.55 times as long as carpus, 1.2 times as long as wide, lower margin as long as carpus; fixed finger evenly tapering, half-length of lower margin, cutting edge smooth; dactylus curved, cutting edge unarmed.

Female major cheliped carpus-palm 1.3 times carapace length; ischium slender, lower (flexor) margin with obsolete proximal denticles; merus essentially as in male; carpus 1.3

times as long as wide, upper and lower margins carinate, rolled mesially; propodus upper margin 0.9 times as long as carpus, 1.2 times as long as greatest width, lower margin of palm carinate; palm distomesial margin with denticulate tubercle at base of fixed finger, with shallow notch between tubercle and fixed finger; fixed finger 0.4 length of lower margin, almost conical, cutting edge minutely denticulate proximally; dactylus 0.8 times as long as upper margin of palm, cutting edge convex, with acute reflexed tip.



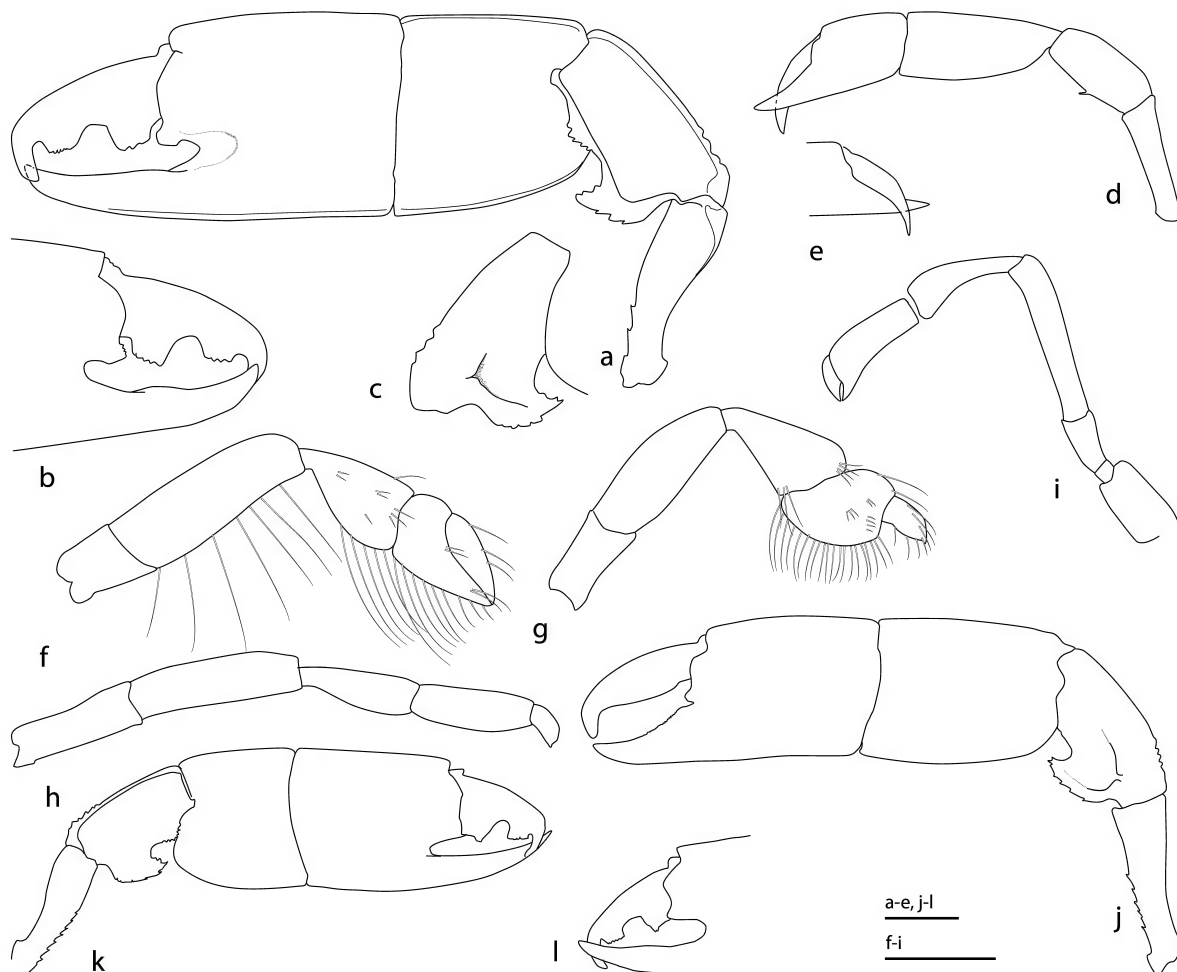


Figure 3. *Arenallianassa arenosa* (Poore, 1975), NMV J16708 (male, cl 6.9 mm): a, major (right) cheliped, mesial face; b, major cheliped fingers, lateral face; c, merus, lateral face; d, minor (left) cheliped, lateral face; e, minor cheliped fingers, mesial face; f, pereopod 2; g, pereopod 3; h, pereopod 4; i, pereopod 5. NMV J16670 (female, cl 7.3 mm): j, major (right) cheliped, lateral. NMV J16726 (male, cl 5.1 mm); k, major (left) cheliped, mesial; l, major cheliped fingers, lateral. Scale bars = 2 mm.

Pereopod 2 chelate; carpus 1.7 times as long as wide; palm twice as wide as upper margin. Pereopod 3 propodus with evenly convex lower margin, proximally reaching lower margin of carpus, almost truncate distally, 1.4 times as long as wide at midlength, with spiniform seta on flexor margin, near distal end, buried among finer setae. Pereopod 4 simple, propodus densely setose laterally. Pereopod 5 chelate, propodus and dactylus densely setose.

Male pleopod 1 of 2 simple articles; article 2 1.7 times as long as article 1. Male pleopod 2 absent.

Uropodal endopod 1.1 times as long as wide, anterior margin gently convex, ending at rounded right angle with distal margin; distal and posterior margins indistinguishable; margins setose; with dorsal cluster of spiniform setae (usually 3 close

together) near anterodistal margin; exopod as wide as anterior margin, anterior margin almost straight, posterodistal margin evenly curved, dorsal plate extending more than half width of exopod, slightly differentiated from distal margin, bearing spiniform setae overlapping setose margin.

Telson slightly wider than long, broadest proximally, tapering to rounded posterolateral corners, posterior margin convex; dorsal surface with c. 5 pairs of fine setae near midpoint.

**Distribution.** Eastern Australia (Gove, Northern Territory, to eastern Tasmania); marine and estuarine bays: intertidal to 25 m.

**Remarks.** *Arenallianassa arenosa* is possibly the most common callianassid in south-eastern Australia. Its ecology has been much studied (Poore, 1975; Coleman and Poore, 1980; Boon et

al., 1997; Bird and Poore, 1999; Bird, 2000; Stapleton et al., 2001; Butler and Bird, 2007, 2008; Butler et al., 2009), mostly incorrectly treated as a species of *Biffarius* Manning and Felder, 1991. Collections in Museums Victoria and the Australian Museum contain hundreds of specimens, mostly from intertidal or shallow beaches or mudflats close to Sydney and Melbourne, of which a few were re-examined here. The record from Gove, Northern Territory, is exceptional; otherwise, the northern-most record is from central Queensland.

The species is separated from other callianassids in Australia by the combination of the telson having convex parallel sides, the broad uropodal rami, operculiform maxilliped 3 with narrow propodus, and the shape of the major cheliped. The distal transverse row of short spiniform setae on the face of the uropodal endopod usually comprises three setae but more can be found sometimes (compare figs 2h, i, j).

Differences from *A. katrinae* sp. nov. are discussed under the species below.

### *Arenallianassa katrinae* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:A8C9C6CA-DF84-4F0F-A939-D0E95002FB53>

Figures 4–7

**Material examined.** Holotype. **New Zealand**, Bay of Plenty, Calypso Vent Field, 37.6125° S, 177.1018° E, 181 m, 27 April 2007, TV grab, RV *Sonne* stn SO192-2/4, NIWA 157709 (male, cl 17.6 mm). Paratypes. Collected with holotype, GenBank: OP178649 (16S), NIWA 157710 (female, cl 16.6 mm); NIWA 157715 (1 female, cl 19.0 mm, mouthparts figured); GenBank: OP178651 (16S), OP174574 (COI), BOLD: DECNZ389-22 (COI), NIWA 157716 (1 male, cl 23.3 mm).

**Additional material.** **Tongan Volcanic Arc**, Volcano 1, 21.143° S, 175.759° W, 111 m, 12 May 2007, TV grab, RV *Sonne* stn SO192-2/63, GenBank: OP178650 (16S), OP174573 (COI), BOLD: DECNZ388-22 (COI), NIWA 32198 (1 female, cl 7.2 mm). **New Zealand**, Bay of Plenty, Calypso Vent Field, 37.612° S, 177.1025° E, 179 m, 07 Oct 1998, TV grab, RV *Sonne* stn SO135/81, NIWA 157435 (1 female, cl 16.7 mm). Calypso Vent Field, same locality as holotype, NIWA 32141 (6 females, cl 5.8–20.8 mm; 5 males, cl 11.5–22.0 mm); NIWA 45911 (4 females, cl 7.6–20.8 mm).

**Diagnosis.** Male major cheliped merus lower margin with prominent oval tooth directed obliquely, followed by prominent denticulate blade near midpoint, squared off distally. Minor cheliped merus lower margin without spine at midpoint. Pereopod 3 propodus subrectangular, proximally distinctly expanded, with evenly concave lower margin. Telson with convex parallel lateral margins.

**Description.** Male. Carapace 0.2–0.3 [0.24] of total length; with distinct linea thalassinica, with defined dorsal oval marked posteriorly by shallow transverse cervical groove (at 0.7 cl) extending anteroventrally to each side above linea thalassinica as shallow groove; frontal margin broadly convex, anterolateral lobe obsolete. Rostrum level with anterior carapace, broadly triangular, acute in dorsal view, reaching about halfway to cornea; orbital margin concave; anterolateral lobe flat, round in dorsal and lateral views; subanterolateral margin oblique, concave; anterior margin of branchiostegite strongly produced.

Pleonites 1 and 2 together as long as carapace; ratio of lengths of pleonites 2–6: 1 : 0.7–1.0 [0.8] : 0.6–[0.7] : [0.8]–0.9 : 0.9.

Eyestalks extending almost to end of antennular peduncle article 1, with distinct mesiodistal lobe; pigmented area covered by large, thinly pigmented, circular dome.

Antennular peduncle about half carapace length; article 1 about as wide as eyestalk; article 3 2.4–[2.6] times as long as article 2, unarmed, with ventrolateral row of long setae. Antennal peduncle as long as antennular peduncle; article 5 0.8–[0.9] times as long as article 4; scaphocerite semicircular in lateral view.

Mandibular molar process with serrate margin, incisor process toothed. Maxillule, maxilla, maxillipeds 1 and 2 as in fig. 6. Maxilliped 3 ischium 1.2–[1.3] as wide as long at meral suture, dilating distally; crista dentata curved, consisting of 14 or 15 small spines, not overlapping ischium-merus suture; merus semicircular, 1.6–[1.7] times as wide as long, 0.8 as long as ischium, distal margin curved beyond base of carpus; propodus [1.4]–1.5 times as long as wide, widest proximally, flexor margin almost straight; dactylus truncate, 0.6 as wide as long, 0.9 times as long as propodus, with convex extensor margin, flexor margin with dense setal brush over distal two-thirds.

Pereopods 1 (chelipeds) unequal, dissimilar, sexually dimorphic. Male major cheliped massive, heterochelous (split even right : left major chela), carpus-palm length (fingers of chelae not included) 1.3–1.4 times carapace length; ischium slender, outer margin concave, lower (flexor) margin with 5–6 proximal spines; ratio of dorsal lengths—merus: carpus: propodus—1:1.0–1.1:1.0–1.3; merus upper margin smooth, lower margin with prominent oval tooth (meral hook) directed obliquely, followed by prominent denticulate blade near midpoint, squared off distally, lateral face with deep, well-defined excavation at base of tooth; carpus slightly wider than long, upper and lower margins carinate, proximal margin convex, overreaching mero-carpal articulation, lower margin serrate in larger individuals; palm 1.0–1.1 times as long as greatest width, lower margin carinate, distolateral margin lobate with tooth at base of fixed finger, strongly excavate between tooth and fixed finger; fixed finger 0.4 length of lower margin, almost conical, cutting edge smooth; dactylus nearly as long as upper margin of palm, cutting edge with blunt tooth in proximal third, second tooth near midpoint, third subdistal. Minor cheliped carpus-palm about as long as carapace; palm 0.35 times width of that of major; ischium narrow, unarmed, subequal to or shorter than meral length; merus twice as long as wide, margins smooth; carpus [1.3]–1.5 times as long as merus, 2.8–[2.9] times as long as wide, parallel-sided over distal half; palm upper margin 0.5 times as long as carpus, [1.2]–1.3 times as long as wide; fixed finger evenly tapering, 0.8 length of lower margin of palm, cutting edge smooth, unarmed; dactylus weakly curved, cutting edge unarmed.

Pereopod 2 chelate; carpus 1.7 times as long as wide; palm twice as wide as upper margin. Pereopod 3 propodus elongate, subrectangular, proximally distinctly expanded, with evenly concave lower margin, 1.9 times as long as wide at midlength; spiniform seta on flexor margin, near distal end, buried among finer setae. Pereopod 4 simple, propodus densely setose laterally. Pereopod 5 chelate, propodus and dactylus densely setose.

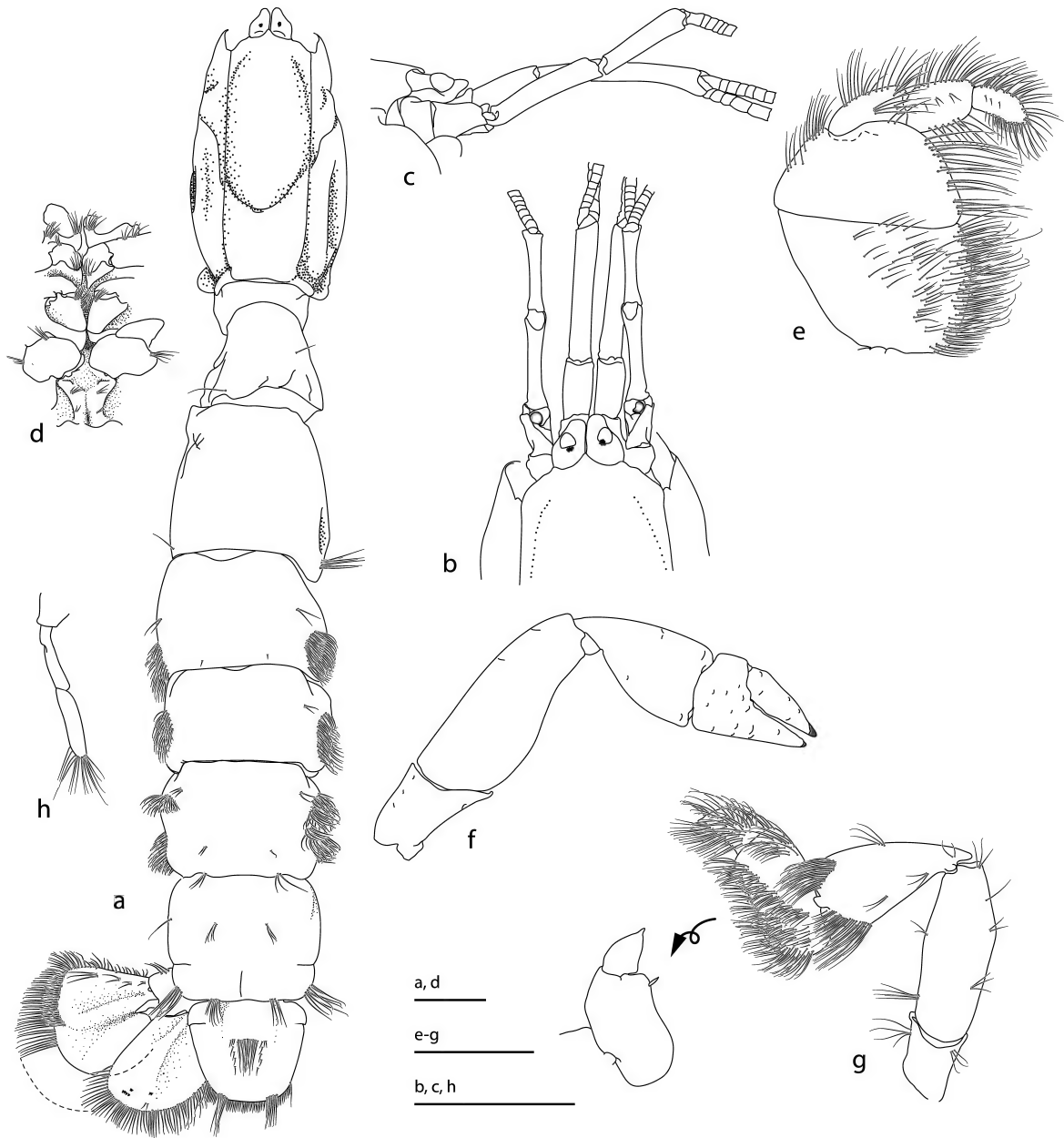


Figure 4. *Arenallianassa katrinae* sp. nov. NIWA 157709 (holotype male, cl 17.6 mm): a, eyestalks, carapace, pleon, left uropod, telson, dorsal view; b, c anterior carapace, eyestalk, antennule, antenna, dorsal view (b), lateral view (c); d, thoracic sternites 4–7, pereopodal coxae 1–4, ventral view; e, maxilliped 3, lateral face; f, pereopod 2; g, pereopod 3 (lateral view, mesial view of propodus and dactylus); h, pleopod 1, right, lateral view. Scale bars = 5 mm.

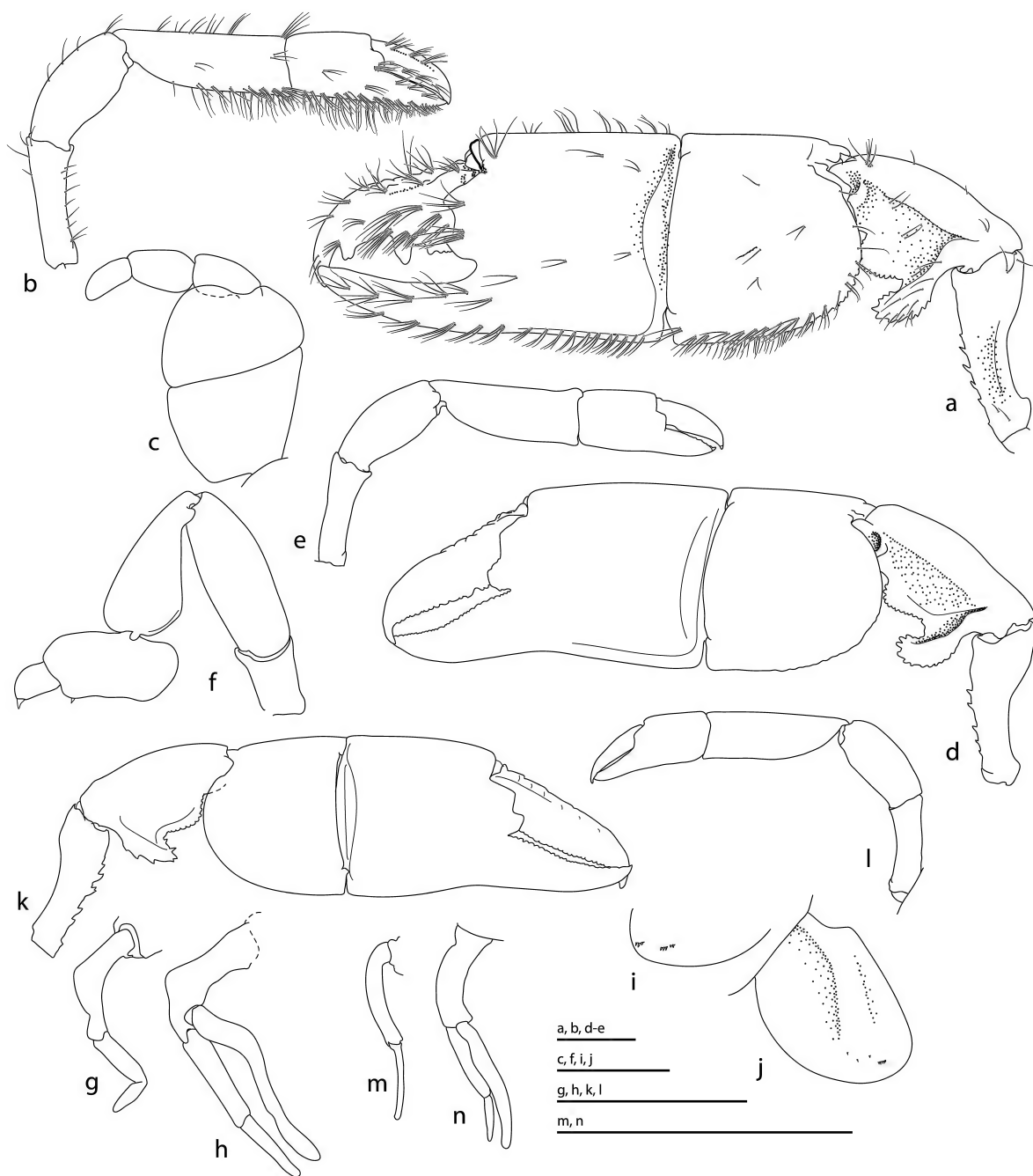


Figure 5. *Arenallianassa katrinae* sp. nov. NIWA 157709 (holotype, male, cl 17.6 mm), lateral view unless stated otherwise: a, major cheliped; b, minor cheliped, right. NIWA 157710 (paratype female, cl 16.6 mm): c, maxilliped 3, left; d, major cheliped, left; e, pereopod 3; f, pleopod 1; g, pleopod 2; h, i, left and right uropodal endopods showing distribution of robust setae. NIWA 32141 (paratype female, cl 9.5 mm): j, major cheliped; k, minor cheliped; l, pleopod 1; m, n, pleopod 2. Top 3 scale bars = 5 mm; bottom scale bar = 2 mm.

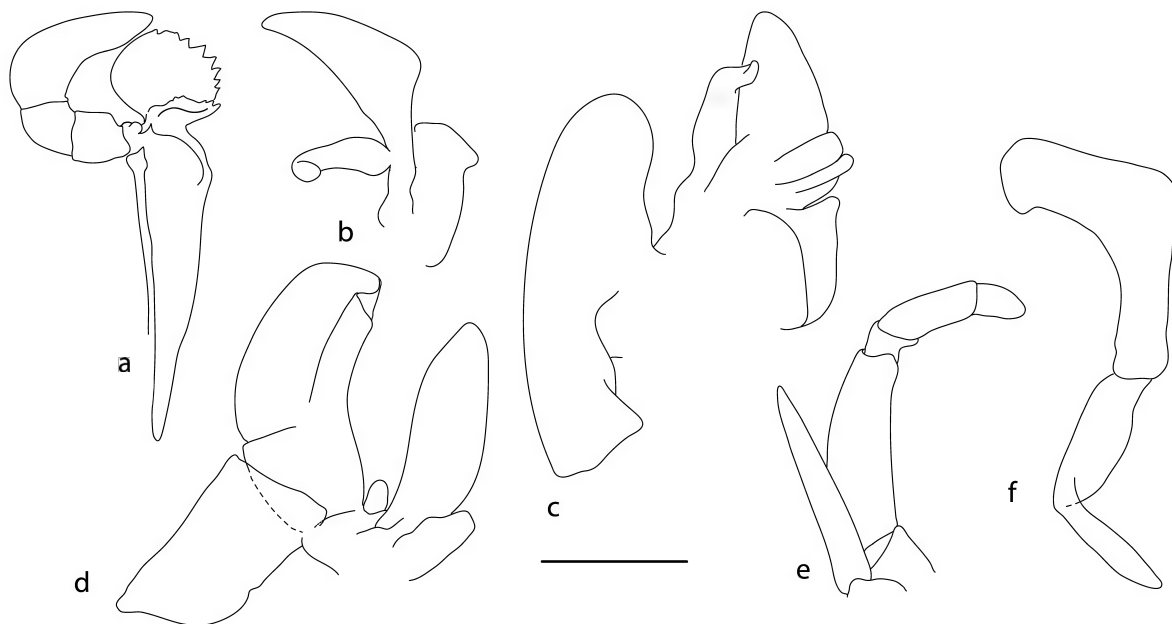


Figure 6. *Arenallianassa katrinae* sp. nov. NIWA 157715 (paratype female, cl 19.0 mm), lateral view unless stated otherwise: a, mandible, left, inside view; b, maxillule; c, maxilla; d, maxilliped 1; e, maxilliped 2; f, pleopod 1, lateral view. Scale bar = 5 mm.

Male pleopod 1 consisting of 2 simple articles, subequal in length. Male pleopod 2 absent. Pleopod 3–5 endopods with small, ovoid appendices internae, embedded at proximal third of mesial margin.

Uropodal endopod anterior margin straight, slightly longer than wide at midlength; distal margin falls away acutely, indistinguishable from posterior margin; margins setose; with variable scattered spiniform setae (usually a cluster of 3–4 distal setae with 2–3 scattered proximally) near anterodistal margin; exopod about as wide as anterior margin, anterior margin almost straight, posterodistal margin evenly curved, dorsal plate extending more than half width of exopod, slightly differentiated from distal margin, setose.

Telson trapezoid, [1.1]–1.2 times as wide as long, distinctly wider proximally, tapering to rounded posterolateral corners, posterior margin shallowly convex; dorsal surface with cluster of long, fine setae near midpoint.

**Female.** Major cheliped carpus–palm 1.4–1.7 times carapace length; ischium, merus and carpus essentially as in male; palm upper margin 1.2–1.3 as long as carpus, 1.0–1.2 times as long as greatest width, lower margin carinate, distolateral margin projected, with truncate lobe above base of fixed finger, with small notch between lobe and fixed finger; fixed finger 0.4 length of lower margin, almost conical, cutting edge denticulate; dactylus about as long as upper margin of palm, cutting edge straight, denticulate, with acute reflexed tip.

Pleopod 1 uniramous, 2-articulate, first article strongly curved in larger females, with clusters of long setae, indistinct in smaller females (cl less than ~10 mm); second article slightly

expanded medially and curved distally (slightly curved in small females, fully folded in large females). Pleopod 2 biramous, exopod narrow, curved, longer than 2-articulate endopod.

**Colour.** Dorsal oval of the carapace, chelipeds and pereopods pale, rest of carapace, pleon and tailfan darker, peach to reddish-brown (fig. 7 inset).

**Etymology.** Named for benthic ecologist Katrin Berkenbusch, in acknowledgment of her research on ghost shrimp ecology in Aotearoa/New Zealand.

**Distribution.** Kermadec and Tonga Volcanic Arc systems, from Bay of Plenty, New Zealand, to Tonga, collected around active venting (Calypso Vent Field and Volcano 1 off Tonga); 111–181 m (fig. 7).

**Remarks.** The molecular and morphological evidence shows that *A. katrinae* sp. nov. is clearly aligned with *A. arenosa* from south-eastern Australia, which occurs at a shallower depth of usually < 25 m depth and is the only other member of the genus.

Diagnostic differences between the two species are small variations in the proportions of the carapace, namely that the transverse cervical groove is at 0.7 cl in *A. katrinae* (0.8 cl in *A. arenosa*); the maxilliped 3 with the ischium wider at ischio-meral suture than long in *A. katrinae* (longer than wide in *A. arenosa*); the maxilliped 3 merus is 0.8 times as long as the ischium in *A. katrinae* (0.6 in *A. arenosa*); the major chelipeds in both males and females share the pronounced serrated meral hook but in *A. katrinae* a serrate semi-circular lobate carina is placed distally, more pronounced than apparent in *A. arenosa* and irrespective of size of the specimen; the palm of the female

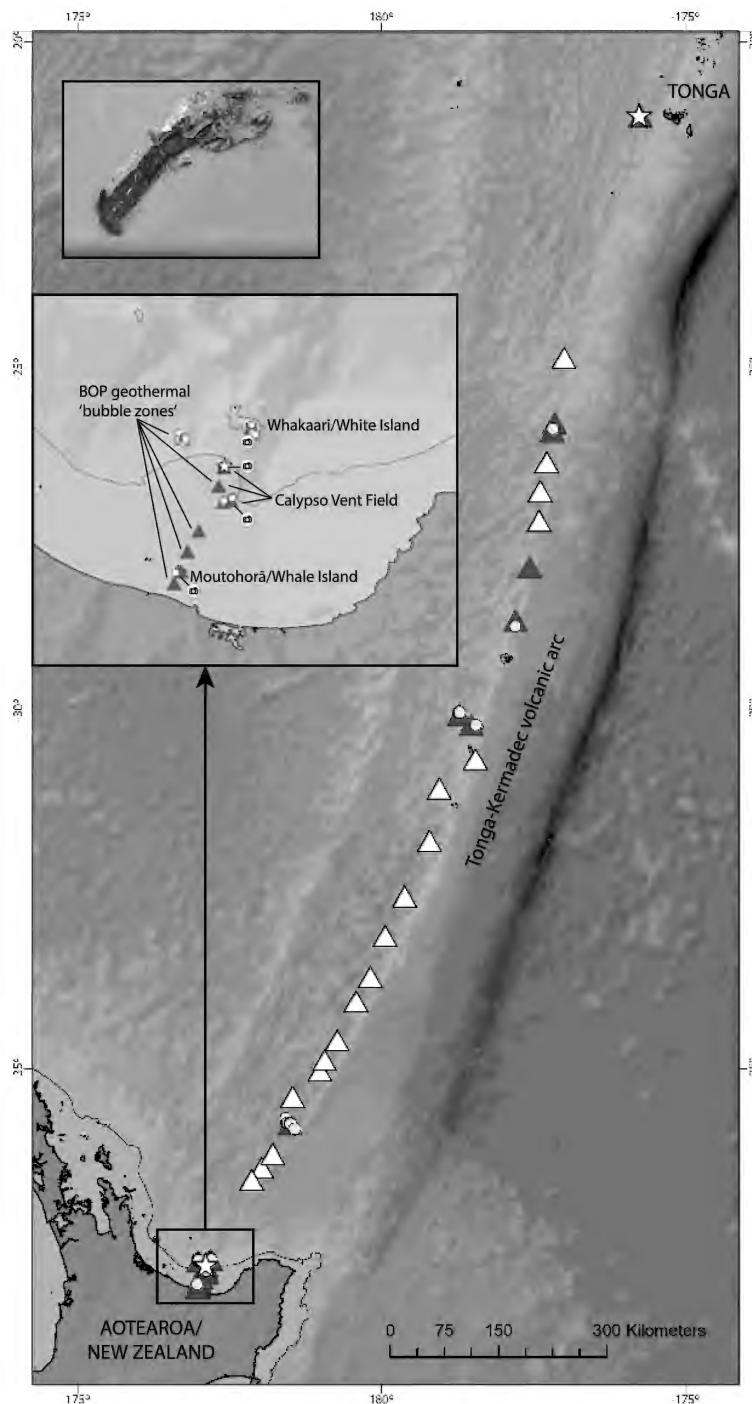


Figure 7. Sample locations of *Arenallianassa katrinae* sp. nov. (white stars). Known hydrothermal vent locations along the Kermadec-Tonga Volcanic Arc are shown in triangles with shallow ( $\leq 200$  m) vents in grey and deep ( $> 200$  m) vents in white. Locations where invertebrate specimens were collected at depths  $\leq 200$  m are indicated by white circles. The 200 m bathymetric line is shown. Lower insert shows close-up of Bay of Plenty (BOP) including locations of geothermal 'bubble zones' reported by Sarano et al. (1989). Upper insert shows colour of an undetermined specimen from type locality (RV Sonne stn SO192-2/4). Camera symbols indicate locations of 2010 camera tows.

major cheliped is proportionally longer in *A. katrinae* (longer than the carpus; shorter in *A. arenosa*); the minor cheliped ischium is subequal in length to the merus in *A. katrinae* (longer in *A. arenosa*) and the carpus is narrower (2.8–2.9 times as long as wide in *A. katrinae*, 2.3 times in *A. arenosa*), most notably, the lower margin of the merus is smooth in *A. katrinae* (with a spine at midlength in *A. arenosa*); pereopod 3 propodus is subquadrate and longer, 1.9 times as long as wide in *A. katrinae* with a slightly concave lower margin (1.4 times as long as wide and convex lower margin in *A. arenosa*); the telson is distinctly trapezoid in *A. katrinae* (subquadrate in *A. arenosa*).

Both species share short spiniform setae towards the distal end of the uropodal endopod upper face; *A. katrinae* usually bears a short transverse row of 3–7 setae, and usually 2–3 further single setae or pairs scattered across the posterolateral face (figs 4a, 5h, i, j).

A single female (NIWA 32198) was collected from Volcano 1 off Tonga that matches the description of the new species. However, DNA sequence information indicates some significant divergence (see remarks above) that need to be resolved, pending the collection of further material.

### Ecological remarks

At least seven species of axiideans have been recorded among chemosynthetic-based communities at hydrothermal vents and cold seeps (including mud volcanoes and pockmarks) in the NE and NW Pacific Ocean, NE Atlantic Ocean, and the Mediterranean Sea, in water depths from 12 to 1339 m (summarised by García Raso et al., 2019). These records, which occur primarily in the deep sea (> 200 m), support benthic communities largely based on chemoautotrophy. As well as chemoautotrophic organisms, heterotrophic fauna can be found at or in the vicinity of these sites, where they can benefit from enhanced food availability if they are able to tolerate the environmental conditions (Erickson et al., 2009). In the South Pacific Ocean, an undescribed species of *Vulcanocalliax* Dworschak and Cunha, 2007 and *Paraglypturus tonganus* Ahn, Kim, Ju and Min, 2017 (both Eucalliidae) have been recorded at cold seep and hydrothermal vent sites, respectively (Lörz et al., 2008; Ahn et al., 2017).

Current records for *A. katrinae* sp. nov. are restricted to sites of hydrothermal venting in relatively shallow water (111–181 m) in the Bay of Plenty and 1951 km distant on Volcano 1 on the Tongan Volcanic Arc (fig. 7). The apparently disjunct distribution of *A. katrinae* is likely to be partly explained by habitat availability. This species, like other callianassids, requires soft sandy or muddy sediment in which to burrow. Such habitat is abundant on the shelf in the Bay of Plenty but relatively rare and patchy on the intervening volcanoes of the Kermadec and Tongan Volcanic Arcs. Some of these volcanoes at water depths < 200 m (fig. 7) have been sampled but not with the TV grab used to make the collections reported here. This hydraulic grab can be guided to target soft sediment, is large, can consistently take samples to sediment depths of 50 cm and has successfully recovered ghost shrimp (Ahn et al., 2017). Small grab samplers are successful in shallow water for ghost shrimps up to about 25 mm long (e.g. Poore, 1975) but *A.*

*katrinae*, at 70 mm total length, may have eluded sampling at hydrothermal vent sites between the Bay of Plenty and Volcano 1. It is interesting to note that another ghost shrimp *P. tonganus* has been recorded from a hydrothermally active volcano (Volcano 19) about 400 km south of Volcano 1, but at a water depth of 544 m (Ahn et al., 2017).

Seabed photographs taken near the North Calypso Vent Field collection site of *A. katrinae* show numerous burrow holes and mounds (fig. 8A, B) that are similar to those made by callianassids seen elsewhere in the subtidal zone (compare with Rowden et al., 1998: plate 2). Without knowing the number of holes/mounds made by an individual shrimp, it is not possible to use these photographs or other similar photographs obtained from the sites to determine the actual density of *A. katrinae*. However, the large numbers of holes/mounds seen in the photographs suggests that the shrimp is abundant at this site. Although often less abundant than at intertidal sites, subtidal populations of callianassids are known to achieve high densities at sites favourable for their existence (e.g. 59 m<sup>-2</sup>; Rowden and Jones, 1994), particularly in organic rich sediments (~1000 m<sup>-2</sup>; Lemaître and Rodrigues, 1991). Hydrothermal sediments are generally organic-rich and, furthermore, host abundant bacterial communities that thrive in these methanic and sulphidic sediments (Teske et al., 2002). Adult callianassid diet is primarily based on deposited or redeposited organic matter (e.g. *A. arenosa*; Boon et al., 1997) but some callianassids are thought to “garden” or utilise bacteria in their burrows where conditions are suitable (Koller et al., 2006). Thus, it is possible that the apparently abundant population of *A. katrinae* at the Calypso Vent Field could be due to the existence of this type of bacteria/food-rich habitat in the region. While no physical collections of specimens have been attempted at hydrothermal vent sites shallower than the aforementioned sites, seabed photographs taken near Moutohorā/Whale Island and Whakaari/White Island at water depths of 30–244 m also show numerous burrow holes and mounds indicative of the presence of *A. katrinae* (fig. 8C, D). Should these features be confirmed in subsequent samples to have indeed been made by this shrimp, then this species will have to be considered abundant in the Bay of Plenty (e.g. occupying all of the so-called “bubble zones” of Sarano et al., 1989, see fig. 7) than indicated by the current physical records reported here, including at relatively shallow depths. Callianassids are important bioturbators of soft sediment, turning over large volumes of sediment (e.g. 96 kg [dry] m<sup>-2</sup> yr<sup>-1</sup> for an annual density range of 11–25 individuals m<sup>-2</sup>; Berkenbusch and Rowden, 1999), influencing nutrient cycling (Webb and Eyre, 2004) and biodiversity patterns (Berkenbusch et al., 2000). As such, *A. katrinae* is also likely to be an important ecosystem engineer (Berkenbusch and Rowden, 2003), particularly if it occupies large areas of the Bay of Plenty shelf.

### New Zealand Callianassoidea

Yaldwyn and Webber (2011) and Webber et al. (2010) listed four species of ghost shrimps in the family Callianassidae using three subfamilies now treated as families: (1) *Callianassa filholi* (Callianassidae), a common intertidal to

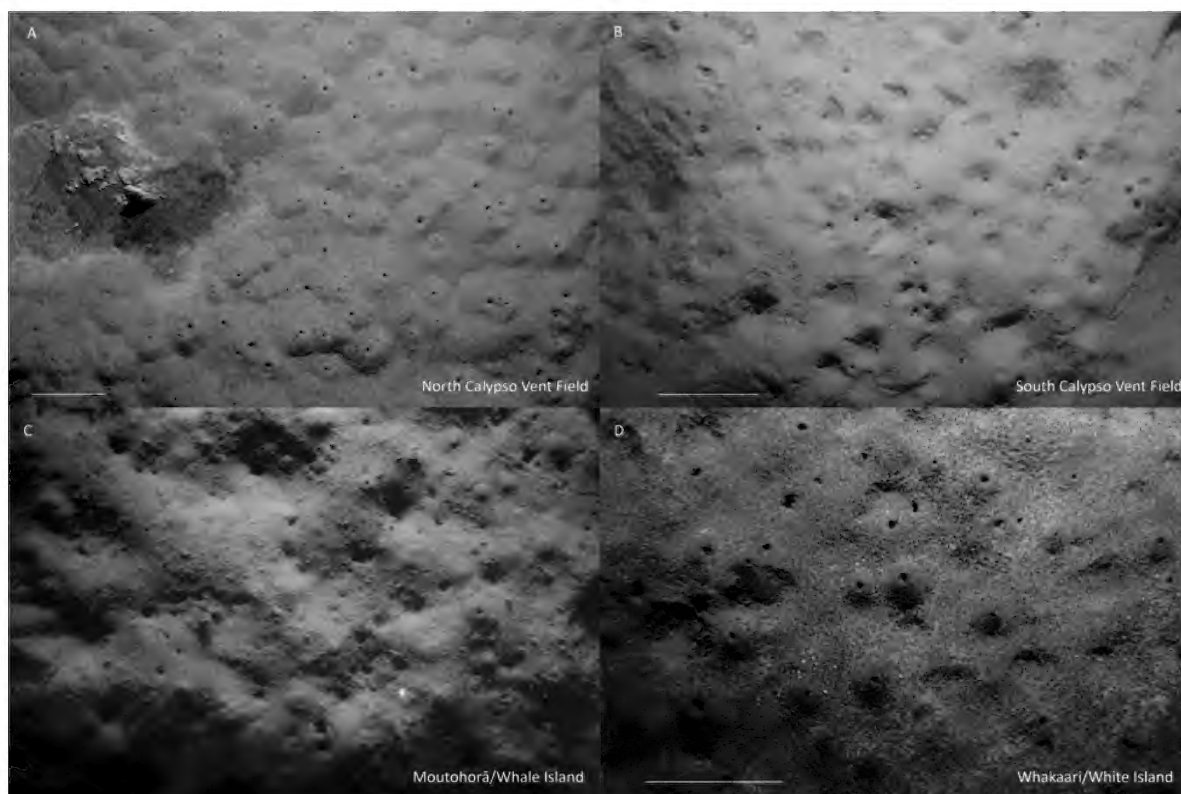


Figure 8. Seafloor images taken by NIWA's Deep-Towed Imaging System (DTIS) camera sled during 2010 RV Kaharoa voyage to the Bay of Plenty. a, North Calypso Vent, stn KAH1004/5, approx. depth 175 m; b, South Calypso Vent, stn KAH1004/8, approx. depth 195 m; c, Moutohorā/Whale Island, stn KAH1004/12, 20–30 m depth; d, Whakaari/White Island, stn KAH1004/14, approx. 225 m depth. Scale bars = 200 mm.

shallow subtidal species endemic throughout New Zealand, now accepted as *Filhollianassa filholi* (A. Milne Edwards, 1879); (2) *Corallianassa articulata* (Callichiridae), the New Zealand record now accepted as *Articullichirus chiltoni* Poore, Dworschak and Schnabel, 2022; (3) *Corallianassa* cf. *collaroy*, reported from New Zealand as *Glypturus collaroy* (Poore and Griffin, 1979) by Sakai (2005) is unlikely to be this Australian species (Poore et al. 2022); and (4) *Vulcanocalliax* sp. (Lörz et al., 2008) (now in Callianopsidae). More recently, Ah Yong (2015) added a single record of *Paratrypaea* sp. from the Kermadec Islands, and *A. katrinae* herein described (both Callianassidae) now brings the known fauna to six species.

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## New records and one new species of Callichiridae (Crustacea, Axiidea) from the Indo-West Pacific, with keys to species of *Corallianassa*, *Lepidophthalmus* and *Neocallichirus*

(<https://zoobank.org/urn:lsid:zoobank.org:pub:5F38D3B8-2255-4559-8C5E-76FE24409F13>)

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### Abstract

Poore, G.C.B. (2023). New records and one new species of Callichiridae (Crustacea, Axiidea) from the Indo-West Pacific with keys to species of *Corallianassa*, *Lepidophthalmus* and *Neocallichirus*. *Memoirs of Museum Victoria* 82: 71–95.

Collections of Callichiridae from surveys of coral reefs and sandy shallow environments in the Indo-West Pacific, particularly Papua New Guinea and Australia, have been used to redescribe and differentiate poorly known species and/or extend the range of others. Keys are provided for identification of the Indo-West Pacific species of *Corallianassa* Manning, 1987 (six species) and *Lepidophthalmus* Holmes, 1904 (four species). The distribution of *Glypturus armatus* (A. Milne-Edwards, 1870) now includes Tonga, within its previously known geographic range. Supplementary descriptions and illustrations are provided for *Michaelcallianassa indica* Sakai, 2002, *Mocallichirus mocambiquensis* (Sakai, 2004) and *Mucrollichirus mucronatus* (Strahl, 1862). The 15 Indo-West Pacific and Australian species of the genus *Neocallichirus* Sakai, 1988 are diagnosed with a key for identification (*N. variabilis* (Edmondson, 1944) excepted). *N. nagoi* sp. nov. is described as a new species.

### Keywords

Crustacea, Axiidea, Callichiridae, *Corallianassa*, *Neocallichirus*, taxonomy, new species

### Introduction

Callichiridae Manning and Felder, 1991 is one of eight families of callianassoid Axiidea de Saint Laurent, 1979, most recently reviewed by Poore et al. (2019). Their classification and the molecular phylogeny on which it was based (Robles et al., 2020) depended in part on extensive collections made in the Indo-West Pacific over the last couple of decades. These collections also made it possible to rediagnose known species and describe another revealed as new during the molecular study. This paper follows an earlier contribution on Eucalliidae (Poore, 2021).

Callichiridae comprise 17 genera, diagnosed by Poore et al. (2019), and 96 species listed by these authors. Another genus, *Articullichirus* Poore, Dworschak and Schnabel, 2022 and three species have been added since (Sepahvand et al., 2020; Hernáez et al., 2022; Poore et al., 2022). This contribution deals with seven of these genera from coral reefs and shallow environments in the Indo-West Pacific and Australia. *Karumballichirus* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 is being dealt with separately. The species of each genus are reviewed. Keys to Indo-West Pacific and Australian species of *Corallianassa*, *Lepidophthalmus* and *Neocallichirus* are provided.

### Methods

Much of the material comes from the Muséum national d'Histoire naturelle, Paris (MNHN), including expeditions to Papua New Guinea, Madang Province (PAPUA NIUGINI stations), and New Ireland Province (KAVIENG 2014 stations), supplemented by the Indo-West Pacific collection of the Florida Museum of Natural History, University of Florida (UF). Specimens from Museums Victoria, Melbourne (NMV); the Australian Museum, Sydney (AM); Western Australian Museum, Perth (WAM); and Northern Territory Museum and Art Gallery, Darwin (NTMAG) were also examined. Material from the Museum für Tierkunde, Dresden (MTKD) is referred to but was not seen. Lists of material examined of common species are shortened to list localities, museums, sexes and size ranges; full details are available online from the museums specified. Unless otherwise stated, station prefixes and numbers belong to systems initiated by the museum holding the material.

Size is expressed as carapace length (cl.), including rostrum, in mm. Individuals marked with an asterisk (\*) were sequenced and contributed to molecular analysis (Robles et al., 2020).

Diagnoses of existing genera can be found in Poore et al. (2019) and in earlier references. Diagnoses of species of *Corallianassa* and *Neocallichirus* were generated from two

newly written DELTA databases (Dallwitz, 2018). Distribution are given in terms of Marine Ecoregions of the World (MEOW) realms or provinces (Spalding et al., 2007) with political terms in parentheses.

### Family Callichiridae Manning and Felder, 1991

#### *Corallianassa* Manning, 1987

**Remarks.** Komai et al. (2015) diagnosed *Corallianassa* in detail. These authors also reviewed the complicated taxonomic history of the 13 species that they recognised. Two, *Corallianassa articulata* (Rathbun, 1906), long regarded as different from the other species (Manning, 1987; Dworschak, 1992), and *C. collaroy* (Poore and Griffin, 1979) have been transferred to another genus, *Articullichirus* Poore, Dworschak and Schnabel, 2022 (Poore et al., 2022). Three widespread Indo-West Pacific species that had been confused have been described relatively recently in detail: *C. coutierei* (Nobili, 1904) by Sakai (1999) and Dworschak (2018); *C. borradailei* (De Man, 1928) by Komai et al. (2015); and *C. martensi* (Miers, 1884) by Dworschak (2014) and Komai et al. (2015). Each species was well supported on a molecular phylogram derived from mitochondrial genes, 16S rRNA and 12S rRNA, plus nuclear genes, histone H3 and 18S rRNA (Robles et al., 2019). Poore et al. (2023) diagnosed and revised the synonymy of four Hawaiian species of *Corallianassa*: *C. borradailei* (De Man, 1928); *C. lanceolata* (Edmondson, 1944); *C. martensi* (Miers, 1884); and *C. oahuensis* (Edmondson, 1944). As a consequence the number of species is now six from the Indo-West Pacific and four from the Americas and Atlantic.

#### Key to Indo-West Pacific species of *Corallianassa*

1. Major cheliped ischium lower margin with row of 4–10 oblique spines increasing in size distally; merus with 2–8 oblique spines or row of blunt tubercles ..... 2
- Major cheliped ischium lower margin with 1 or 2 small spines or obsolete teeth; merus with 2 small spines or row of denticles ..... 4

2. Major cheliped carpus and palm carinate, blade-like along entire upper margin. Minor cheliped palm about as long as wide, fingers longer than palm ..... *C. borradailei* (De Man, 1928)
- Major cheliped carpus and palm obscurely carinate along half of upper margin, with or without carina on distal quarter. Minor cheliped palm longer than wide, fingers about as long or shorter than palm ..... 3
3. Rostrum horizontal. Carapace anterolateral spines evenly tapered, slightly curved inwards. Major cheliped palm obscurely carinate along proximal two-thirds of upper margin ..... *C. coutierei* (Nobili, 1904)
- Rostrum upturned. Carapace anterolateral spines with mesial basal buttress. Major cheliped palm obscurely carinate along proximal half and distal quarter of upper margin ..... *C. oahuensis* (Edmondson, 1944)
4. Rostrum horizontal or almost so. Minor cheliped fingers 0.8–1.1 times as long as palm. Uropod endopod acutely rounded, flat; exopod posterior margin strongly concave ..... *C. martensi* (Miers, 1884)
- Rostrum upturned. Minor cheliped fingers 1.6 times as long as palm. Uropod endopod narrow, acute, upturned; exopod posterior margin slightly concave ..... 5
5. Uropod endopod 2.4 times as long as wide ..... *C. assimilis* (De Man, 1928)
- Uropod endopod 3 times as long as wide; apex attenuated. Hawaii only ..... *C. lanceolata* (Edmondson, 1944)

#### *Corallianassa assimilis* (De Man, 1928)

##### Figure 1

*Callianassa martensi*.—De Man, 1888: 482–483, pl. 21 fig. 1 (not *Callianassa martensi* [Miers, 1884]).

*Callianassa (Callichirus) assimilis* De Man, 1928a: 28, 93, 109

*Glypturus assimilis*.—Sakai, 1999: 78, fig. 16a–f.—Sakai, 2005: 138–139.—Sakai, 2011: 433.

*Callianassa assimilis*.—Tudge et al., 2000: 143.

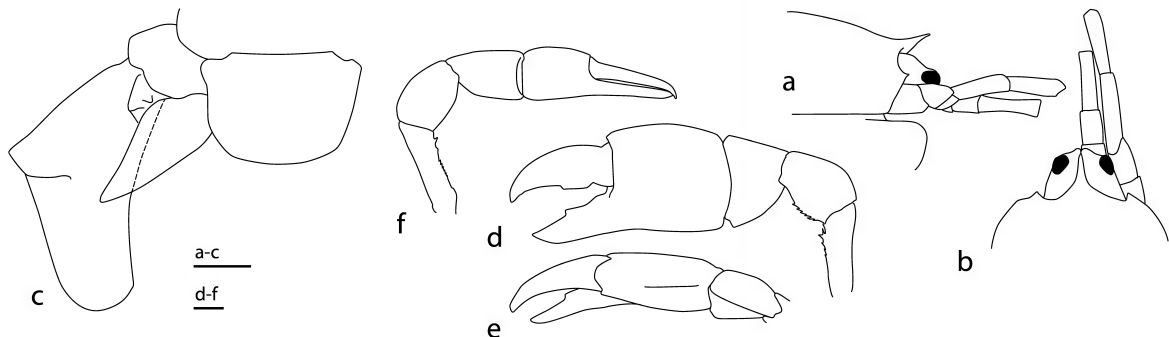


Figure 1. *Corallianassa assimilis* (De Man, 1928), Guam, UF 2961, ovigerous female, 8.1 mm: a, b, anterior carapace, rostrum, antennular peduncle, antennal peduncle; c, telson, left uropod; d, e, major cheliped (right, mesial and upper views); f, minor cheliped (left, mesial view). Scale bars = 1 mm.

*Corallianassa bayeri* Kensley, 2001: 328–332, figs 1, 2.—Sakai, 2011: 424 (type locality, Agat Bay, Guam).

*Corallianassa assimilis*.—Komai et al., 2015: 15 ff.

**Material examined.** **USA**, Mariana Is, Guam, Apra Harbor and Agat Bay, 13.5° N, 144.8° E, 1–12 m, UF 506, UF 538, UF 545, UF 1227, UF 1301, UF 1966, UF 2055, UF 2133, UF 2961, UF 3027 (17 females, 5 ovigerous; 4.1–8.1 mm).

**Diagnosis.** Rostrum upturned; carapace anterolateral spines triangular, short. Maxilliped 3 ischium-merus 2.5 times as long as wide; merus mesiodistal margin convex; propodus, free distal margin oblique. Major cheliped ischium lower margin with 2 small distal spines; merus lower margin with row of distally diminishing denticles; palm as long as wide, upper margin obscurely carinate along proximal half. Minor cheliped merus lower margin smooth; palm 1.3 times as long as wide, tapering; fingers longer than palm, straight. Uropodal endopod 2.4 times as long as wide; anterior margin convex over most of length; posterior margin convex; apex narrow, acute, upturned. Uropodal exopod posterior margin slightly concave; proximal article with blunt lobe overlapping endopod. Telson slightly tapering, 1.5 times as wide as long; posterior margin evenly convex; dorsal surface with about 6 pairs of fine setae separated by median gap on transverse ridge.

**Distribution.** Tropical Northwestern Pacific, Western Coral Triangle (Indonesia [type locality: Ambon], Guam).

**Remarks.** *Corallianassa assimilis* has a more acute uropodal endopod tip than *C. martensi* but less so than *C. lanceolata*. Moreover, the endopod has a strong middorsal ridge and an upturned distal tip. The species was described from Ambon, Indonesia, and its accepted synonym, *C. bayeri* Kensley, 2001, from Guam. Sakai (2011) treated the two as synonyms of “*Glypturus*” *assimilis* on one page but also as separate species in two genera. The most convincing of De Man’s (1928) features distinguishing *C. assimilis* and *C. martensi* is the shape of the minor cheliped. The palm of the minor cheliped is more barrel-shaped than in other species of the genus and its fingers are relatively longer (much longer than the palm).

### *Corallianassa coutierei* (Nobili, 1904)

**Material examined.** **Papua New Guinea**, Madang and Kavieng areas, intertidal sandflats, MNHN IU-2013-7073\*, MNHN IU-2014-991, MNHN IU-2014-1089, MNHN IU-2014-2711\*, MNHN IU-2014-10010\* (3 males, 2 females, 3.0–5.5 mm).

**Diagnosis.** Rostrum horizontal; carapace anterolateral spines evenly tapered, slightly curved inwards. Maxilliped 3 ischium-merus twice as long as wide; merus tapering; propodus, free distal margin transverse. Major cheliped ischium lower margin with 4–6 oblique spines increasing in length distally; merus lower margin with row of blunt tubercles; palm as long as wide or slightly longer than wide, upper margin obscurely carinate along proximal two-thirds. Minor cheliped merus lower margin smooth; palm 1.5 times as long as wide, rectangular; fingers as long as palm, curved. Uropodal endopod twice as long as wide; anterior margin evenly convex; posterior margin convex; apex broadly rounded, flat. Uropodal exopod posterior margin almost straight; proximal article with sharp spine overlapping endopod

and smaller accessory proximal lobe. Telson tapering to about two-thirds basal width from basal lobes, 1.7 times as wide as long; posterior margin evenly slightly convex; dorsal surface with about 6 pairs of fine setae in row on transverse ridge.

**Distribution.** Western, Central and Eastern Indo-Pacific [type locality: Djibouti] (see Dworschak, 2018).

**Remarks.** Komai et al. (2015) and Dworschak (2018) reviewed the complicated history of this name and recognised the species as distinct from *C. borradailei*, with which it had been confused. All specimens from Papua New Guinea are small and lack the carinate chelipeds that characterise *C. borradailei*. *Corallianassa coutierei* is best diagnosed by the short obsolete carina along half the upper margin of the major cheliped palm and the denticles (not spines) on the lower margin of the major cheliped merus. Genetic diversity among individuals from Papua New Guinea and Philippines is low (Robles et al., 2020).

Sakai (1999) designated and illustrated Nobili’s (1904) specimen from Djibouti (MNHN Th75) as the lectotype. Other syntype specimens came from Périm and Aden. *Callianassa placida* De Man, 1905 is a well accepted synonym (Ngoc-Ho, 2005; Komai et al., 215) but records of *Callianassa* (*Callichirus*) *placida* from Clipperton I., northeastern Pacific (Chace, 1962), and from Isla Clarion, Mexico (Hernández-Aguilera et al., 1986) are referable to *Corallianassa xutha* Manning, 1988.

### *Glypturus Stimpson, 1866*

**Remarks.** Komai et al. (2015) diagnosed *Glypturus* in detail, listing three species. For a fourth species, see Felder (2019).

### *Glypturus armatus* (A. Milne-Edwards, 1870)

*Callianassa armata* A. Milne-Edwards, 1870: 90, 101, pl. 1.

*Glypturus armatus*.—Komai et al., 2015: 18–29, figs 1–7 (redescription, synonymy).—Dworschak, 2018: 21–22, figs 3, 4.—Poore et al., 2019: 136, 144, fig. 15k.—Robles et al., 2020.

**Material examined.** **Australia**, Northern Territory, Arafura Sea, 9.377° S, 134.215° E, 105 m (CSIRO cruise SS05/2005, stn 015BS004), AM P74496 (female). **USA**, Marinas Is, Guam, burrows in seagrass, 0–1 m, UF (1 male). **Papua New Guinea**, Madang area, intertidal mudflats, MNHN (3 specimens, 6–12 mm). Kavieng, intertidal, MNHN (1 specimen). **Tonga**, Tongatapu, intertidal sandflat, NMV J6120 (2 males, 1 female, 11–18 mm). **French Polynesia**, Moorea, mudflats, 0–0.5 m, UF (4 specimens, 11–22 mm), MNHN (2 specimens).

**Size.** Cl. to 38.8 mm.

**Distribution.** Central and Eastern Indo-Pacific (Vietnam; Japan, Ryuku Is; Philippines; Mariana Is; Indonesia; Papua New Guinea; Australia, NT; Fiji [type locality]; Tonga; New Caledonia; French Polynesia); intertidal to 105 m.

**Remarks.** *Glypturus armatus* is a well-known species recently redescribed (Komai et al., 2015; Dworschak, 2018). These new records are within its known geographic range, but the species has not been previously recorded from Tonga or at depths greater than 30 m. Molecular data do not distinguish Papua New Guinea examples from representatives from the Philippines or from Tonga (Robles et al., 2020).

***Glypturus laurae* de Saint Laurent in Vaugelas and de Saint Laurent, 1984**

Figure 2

*Callichirus laurae* de Saint Laurent in de Vaugelas and de Saint Laurent, 1984: 147, pl. 1A–D.

*Glypturus laurae*.—Poore and Suchanek, 1988: 201, fig. 4c.—Dworschak, 1992: 209.—Tudge et al., 2000: 144.—Robles et al., 2009: 317.—Poore et al., 2019: 144.—Robles et al., 2020: figs 1, 4, 7, tables S1, S2.—Dworschak, 2022: 255–256.

*Glypturus armatus*.—Sakai, 2011: 432–433 (part).

**Material examined.** Saudi Arabia, Al Lith, 20.167155° N, 40.223307° E, near mangroves, 1–2 m, UF 37164 (female, 12 mm).

**Distribution.** Red Sea and Gulf of Aden; Sunda Shelf (Jordan [type locality: Aqaba]; Saudi Arabia; Singapore).

**Remarks.** The single small individual was identified more on the basis of its proximity to the type locality in the Red Sea than morphology. Contrary to Poore and Suchanek's (1988) assertion, the shape of the uropod seems not to be a reliable difference between the species now recognised (Komai et al., 2015). The uropodal exopod is more tapered in this specimen than in adults of 35 mm carapace length (fig. 2). Nor does it possess the tubercles on the distolateral face of the cheliped said by Komai et al. (2015) to differentiate it from *G. armatus* and seen on a topotypic specimen (NMV J11514). Molecular analysis found *G. laurae* and *G. armatus* to differ widely (Robles et al., 2020), contradicting Sakai's (2011) synonymy. Dworschak (2022) found the species in Singapore, far from its type locality.

***Lepidophthalmus* Holmes, 1904**

**Remarks.** Komai et al. (2018) diagnosed the genus and discussed its synonymy at length. Four species have been recorded from the Indo-West Pacific: *L. grandidieri* (Coutière, 1899); *L. madagassus* (Lenz and Richters, 1881); *L. rosae* (Nobili, 1904); and *L. tridentatus* (von Martens, 1868); three occur in these collections.

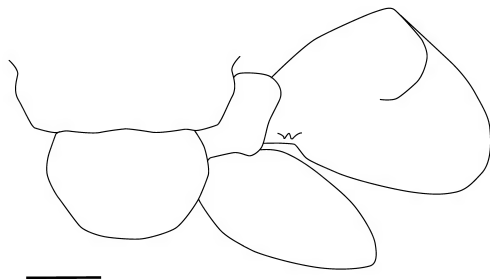


Figure 2. *Glypturus laurae* de Saint Laurent in Vaugelas and de Saint Laurent, 1984. Saudi Arabia, UF 37164, female, 12 mm: telson, right uropod. Scale bar = 1 mm.

**Key to the Indo-West Pacific species of *Lepidophthalmus***

1. Major cheliped carpus, propodus, dactylus upper margins without teeth ..... 2
- Major cheliped carpus, propodus, dactylus upper margins dentate ..... 3
2. Rostrum acute, simple ..... *L. rosae*
- Rostrum trifid, lateral spines shorter than medial spine ..... *L. tridentatus*
3. Major cheliped distal carpus, propodus, dactylus upper margin dentate. Rostrum trifid, lateral spines as long as medial spine ..... *L. grandidieri*
- Major cheliped dactylus swollen, upper and lower margins dentate; fixed finger with 2 dentate cutting edges. Rostrum acute, simple ..... *L. madagassus*

***Lepidophthalmus grandidieri* (Coutière, 1899)**

*Callianassa Grandidieri* Coutière, 1899: 285–287, figs 1–5.

*Callianassa (Callichirus) Grandidieri*.—Borradaile, 1903: 547.—De Man, 1928a: 28, 92, 110.

*Lepidophthalmus grandidieri*.—Sakai, 1999: 71.—Sakai, 2005: 151.—Poore et al., 2019: 144.—Sakai, 2011: 448–449.

**Diagnosis.** Major cheliped distal carpus, propodus, dactylus upper margin dentate. Rostrum trifid, lateral spines as long as medial spine. Cl. 8 mm.

**Distribution.** Western Indian Ocean (Madagascar, Mahanara R. estuary [known only from type locality]).

**Remarks.** *Lepidophthalmus grandidieri* has not been recorded since its description.

***Lepidophthalmus madagassus* (Lenz and Richters, 1881)**

Figure 3

*Callianassa madagassa* Lenz and Richters, 1881: 427, figs 20–23.

*Lepidophthalmus socotrensis* Sakai and Apel, 2002: 278–285, figs 3–7 (type locality, Socotra, Yemen).

*Podocallichirus madagassus*.—Sakai, 1999: 56–58, fig. 10.—Sakai, 2011: 467, fig. 66C, D (synonymy).—Sakai et al., 2014: 502–507, figs 5, 6 (redescription, synonymy).

*Lepidophthalmus madagassus*.—Poore et al., 2019: 144.—Robles et al., 2020: figs 1, 4, 7, tables S1, S2.

**Material examined.** Saudi Arabia. Farasan Is, Tiger Head I., karstic shore, 16.79097° N, 42.19865° E, UF 36969 (1). Thuwal, King Abdullah University of Science and Technology, silty sand flat, south beach, 22.29213° N, 39.09000° E, UF 37048\* + others (4 males, 6 females, 8.4–14 mm). Madagascar, Nosy Bé, MNHN Th409 (1), MNHN Th424 (male), MNHN Th426 (male), NMV J58224 (1).

**Diagnosis.** Major cheliped dactylus swollen, upper and lower margins dentate; fixed finger with 2 dentate cutting edges. Rostrum acute, simple. Cl. to 18.1 mm.

**Distribution.** Red Sea and Gulf of Aden, Western Indian Ocean (Saudi Arabia, Madagascar [type locality]).

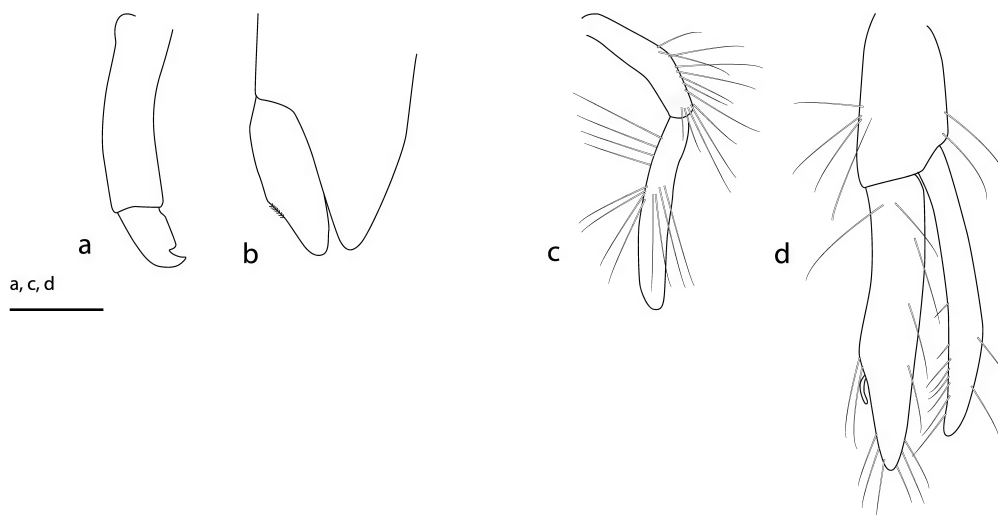


Figure 3. *Lepidophthalmus madagassus* (Lenz and Richters, 1881). Madagascar. MNHN Th426, male: a, pleopod 1; b, pleopod 2 endopod apex. UF 37101, female, 8.4 mm: c, pleopod 1; d, pleopod 2. Scale bar = 1 mm.

**Remarks.** Lenz and Richters (1881) illustrated the minor cheliped that, with its broad spinose dactylus, immediately distinguishes this species from other species of *Lepidophthalmus*, from all other callichirids and from members of related families. Sakai et al. (2014) synonymised *L. socotrensis* with *Podocallichirus madagassus* [sic]; the new material would seem to confirm this and any differences in the shapes of the uropod and telson are size-related. The species' range is extended into the Red Sea.

The male pleopod 1 has a short second article with a distal triangular apex (fig. 3a); pleopod 2 has an appendix masculina bearing a small field of hooks, all that remains of the appendix interna (fig. 3b) – not as complicated as in Sakai (1999: fig. 10). Female pleopods are typical of the genus (fig. 3c, d)—the appendix interna on pleopod 2 is placed about two-thirds along the mesial margin of the endopod.

### *Lepidophthalmus rosae* (Nobili, 1904)

*Callianassa* (*Callichirus*) *rosae* Nobili, 1904: 237.—Nobili, 1906: 108–110, pl. 7 fig. 2.—De Man, 1928a: 29, 110.—Balss, 1933: 88–89, fig. 2.

*Lepidophthalmus rosae*.—Sakai, 1999: 71, fig. 14g–h.—Sakai, 2005: 151, figs 30–32.—Poore et al., 2019: 144.—Robles et al., 2020: figs 1, 4, 7, tables S1, S2.

*Callianassa rosae*.—Tudge et al., 2000: 143.

*Lepidophthalmoides rosae*.—Sakai, 2011: 444.—Sakai and Türkay, 2014: 179.

**Material examined.** **Australia**, Northern Territory, Darwin Harbour, Vestey's Beach, 12° 22' S, 130° 50' E, intertidal, NTMAG Cr016691 (2 males, 11, 14 mm; 3 females, 12–15 mm). Fannie Bay Beach, 12° 25' S, 130° 50' E, intertidal, NTMAG Cr016692 (2 males, 11, 13 mm; 3 ovigerous females, 13–14 mm), NTMAG Cr013046 (ovigerous female, 15 mm), NTMAG Cr013047 (3 males, 6–8 mm), NTMAG Cr016693 (male, 8 mm). Gove, sandy beach and reef, 12° 12' S, 136° 43' E, intertidal, NTMAG Cr009850 (5 males, 4–9 mm).

**Diagnosis.** Major cheliped carpus, propodus, dactylus upper margins without teeth. Rostrum acute, simple. Cl. to 16 mm.

**Distribution.** Western and Central Indo-Pacific (Red Sea [type locality]; Madagascar; Indonesia; Australia, NT; Philippines).

**Remarks.** *Lepidophthalmus rosae* is notable for the sharp curved proximal spine on the lower margin of the merus of the major cheliped, prominent in males, combined with the subrectangular telson with a bilobed posterior margin, broader than long, and lanceolate acute uropodal endopod. The species has been recorded from the type locality in the Red Sea to Indonesia (Balss, 1933; Sakai, 2005), Madagascar (Sakai, 1999) and the Philippines (Sakai, 2005). It is no surprise that it is common on beaches in northern Australia.

### *Lepidophthalmus tridentatus* (von Martens, 1868)

*Callianassa tridentata* von Martens, 1868: 614–615.

*Lepidophthalmus tridentatus*.—Dworschak, 2007: 122–129, figs 2–39.—Komai et al., 2018: 10–23, figs 1–7 (redescription, synonymy).—Dworschak, 2018: 21 (synonymy, distribution).—Poore et al., 2019: 144.—Robles et al., 2020: 128, figs 1, 4, 7, tables S1, S2.

**Material examined.** **Samoa**, Tutuila I., Leone Bay, sand flat (stn BTUT-011), UF 2224 (male, 11.0 mm; female, 13.5 mm).

**Diagnosis.** Major cheliped carpus, propodus, dactylus upper margins without teeth. Rostrum trifid, lateral spines shorter than medial spine. Cl. to 18 mm.

**Distribution.** Western and Central Indo-Pacific (Sri Lanka; Indonesia [type locality: Java]; Papua New Guinea; Samoa; Philippines; Japan, Ryuku Is).

**Remarks.** *Lepidophthalmus tridentatus* is notable for the prominent triangular anterolateral carapace angles, the broadly convex posterior margin of the telson and the subrhomboidal

uropodal endopod. The species was described from Java, Indonesia, by von Martens (1868) and subsequently reported from Sri Lanka (Miers, 1884; Sakai, 1970, 1999), New Britain, Papua New Guinea (Sakai, 1970), Bali, Indonesia (Dworschak, 2018), Philippines (Dworschak, 2007) and Japan (Sakai, 2011; Dworschak, 2018; Komai et al., 2018). This is the first record from Samoa, and extends the range of the species well into the Central South Pacific. Sakai's (2011) "Diagnosis" mentioned only the male pleopods, neither diagnostic, and is in error. The male pleopod 1 is biarticulate with a simple short second article, not "chelate", and the male pleopod 2 is biramous with a weakly demarcated appendix masculina and small appendix interna on the endopod as typical of the genus (Dworschak, 2007: figs 37–39). Dworschak (2007) noted that his material from the Philippines, with a total length of 22–47 mm, was much smaller than previous records. The specimens from Samoa are within this range.

### *Michaelcallianassa* Sakai, 2002

*Michaelcallianassa* Sakai, 2002: 480–481.—Sakai, 2005: 156–157.—Sakai, 2011: 450.—Poore et al., 2019: 113.

**Remarks.** *Michaelcallianassa* is most easily recognised by the tapering telson with pairs of robust setae on the dorsal surface. Three species are known: *M. indica* Sakai, 2002 from the Persian Gulf (type locality), Bay of Bengal and the Andaman Sea (Sakai, 2002, 2005; Robles et al., 2020); *M. persica* Sepahvand, Momtazi and Tudge, 2020 from the Persian Gulf; and *M. sinica* Liu and Liu, 2009 from the South China Sea and

Singapore (Dworschak and Anker, 2022). Sepahvand et al. (2020) compared the three species in a table.

### *Michaelcallianassa indica* Sakai, 2002

#### Figure 4

*Michaelcallianassa indica* Sakai, 2002: 481–488, figs 11–14.—Sakai, 2005: 157–160, fig. 33.—Sakai, 2011: 450–451.—Robles et al., 2020: figs 1, 4, 7, tables S1, S2.—Padate et al., 2022: 198 (list).—Al-Kandari et al., 2020: 271, fig. 13.

**Material examined.** **Australia**, Arafura Sea, 10° 29.2' S, 134° 20.3' E, 57–59 m (R. Williams stn RW92–49), NTMAG Cr009817 (male, 5.6 mm).

**Supplementary description of male.** Carapace c. 0.3 times total length; with distinct linea thalassinica, with defined dorsal oval marked posteriorly by shallow transverse cervical groove extending anteroventrally to each side above linea thalassinica as shallow groove demarcating posterior half of dorsal oval; frontal margin continued ventrolaterally beyond anterolateral lobe as ridge towards linea thalassinica. Branchiostegite with oblique groove terminating at anterior end of rounded hepatic boss; anterior branchiostegal lobe articulating at junction of oblique ridge and linea thalassinica. Rostrum strongly convex in lateral view, narrowly triangular, reaching almost to cornea; anterolateral lobe flat, rounded in dorsal view, square in lateral view.

Antennular peduncle 0.55 times carapace length, article 3 1.8 times as long as article 2, with ventrolateral rows of long setae. Antennal peduncle just exceeding antennular peduncle; article 4 with 3 long dorsal setae; article 5 little longer than

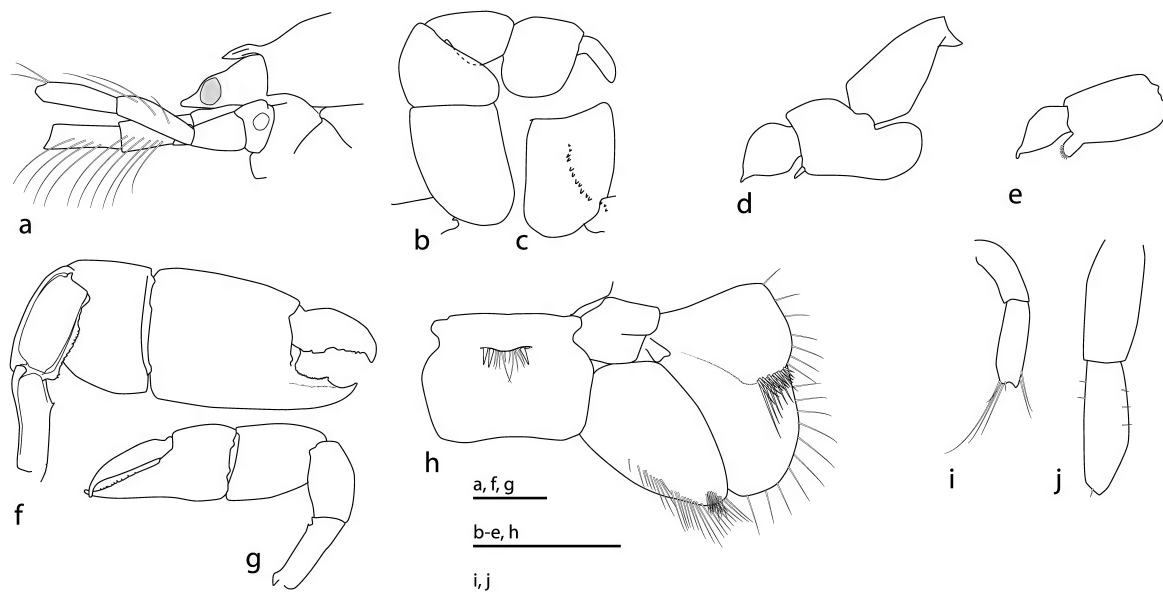


Figure 4. *Michaelcallianassa indica* Sakai, 2002. Australia, Arafura Sea, NTMAG Cr009817, male, 5.6 mm: a, front of carapace, eyestalks, antennular peduncle, antennal peduncle; b, c, right maxilliped 3, lateral, mesial basis and ischium; d, pereopod 3, carpus–dactylus; e, pereopod 4, propodus, dactylus; f, major cheliped (left, mesial); g, minor cheliped (right, mesial); h, telson, right uropod; i, j, pleopods 1, 2 (right, posterior view). Scale bars = 1 mm.



article 4; scaphocerite semicircular. Maxilliped 3 ischium 1.4 times as long as wide, proximally lobed, widest at midpoint, extensor margin slightly concave, flexor margin straight; merus subtriangular, 1.2 times as wide as long, flexor margin broadly rounded, distal margin oblique; carpus suboval, 1.6 times as long as wide, with lobe on flexor margin; propodus 1.1 times as wide as long, free distal margin slightly oblique, flexor margin almost semicircular; dactylus slightly arcuate, 0.7 times as long as propodus; crista dentata curved, of 3 small spines on basis, 11 uneven short sharp spines on proximal two-thirds of ischium.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped carpus–dactylus 1.5 times carapace length; ischium slender, lower (flexor) margin with 1 denticle just beyond midpoint; merus twice as long as wide, upper margin arcuate, lower margin with c. 12 denticles over proximal two-thirds, first 2 slightly more prominent; carpus 1.6 times as wide as long, lower proximal margin regularly curved; propodus upper margin twice as long as carpus, 1.1 times as long as greatest width, widest proximally, upper and lower margins of palm carinate, rolled mesially; palm distomesial margin with blunt tubercle at base of fixed finger; fixed finger one-third length of lower margin, twice as long as width at base, cutting edge lateral, with finely serrate concave blade over proximal half, smooth, concave beyond; dactylus 0.6 as long as upper margin of palm, cutting edge with blunt tooth in proximal half, irregularly toothed beyond, with acute hooked tip. Minor cheliped 1.2 times carapace length; palm 0.6 width of major; ischium narrow, with small tooth on flexor margin, as long as merus; merus 1.8 times as long as wide, margins curved, unarmed; carpus longer than merus, 1.2 times as long as wide, parallel-sided over distal half; palm upper margin 0.7 times as long as carpus, 0.8 times as long as wide, lower margin 1.6 times as long as carpus; fixed finger evenly tapering, more than half length of lower margin, cutting edge with 10 well-spaced denticles over distal half; dactylus 1.7 times as long as upper margin of palm, curved, cutting edge unarmed.

Pereopod 3 propodus with proximally directed rounded lobe of lower margin extending beyond lower margin of carpus, with spiniform seta on lower distal angle; dactylus broadly teardrop-shaped, 1.5 times as long as wide. Pereopod 4 propodus with distal thumb, its margin with c. 10 marginal sharp short setae.

Male pleopod 1 of 2 articles; article 2 longer than article 1, with distolateral triangular projection, with rounded distomesial lobe bearing long setae. Male pleopod 2 of 2 articles; article 2 longer than article 1, lateral margin convex, apex oblique; without appendix masculina. Pleopod 3 endopod with appendix interna embedded in mesial margin, with minute hooks.

Uropodal endopod 1.65 times as long as wide, anterior and posterior margins converging on rounded corner, posterior margin with subdistal cluster of dorsal setae, submarginal row of setae; exopod 1.8 times as wide as anterior margin, anterior margin almost straight, distal margin evenly curved, delimited each end by rounded angles, dorsal plate extending almost half width of exopod, bearing c. 30 spiniform setae on overlapping margin.

Telson 1.33 times wide as long, broadest at lateral lobes near midpoint, with strong lateral excision near anterior margin, tapering to rounded posterolateral corners, posterior margin weakly concave, posterolateral corners each bearing tuft of long

setae; dorsal surface with prominent transverse ridge, 2 pairs of spiniform setae and 5 pairs of fine setae posterior to ridge.

*Size.* Cl. 9.5 mm.

*Distribution.* Somali/Arabian, Bay of Bengal, Andaman, Sahul Shelf (Persian Gulf [type locality]; Kuwait; Iran; India; Australia, NT); 0–65 m.

*Remarks.* Sakai (2002) selected a large male, the only specimen from the Persian Gulf, as holotype of *M. indica* and listed many specimens from the Andaman Sea as paratypes. Sakai (2005) added more records from the south-eastern coast of India. Robles et al. (2020) recorded a second specimen from the Persian Gulf that contributed molecular data to their analysis. The small male figured here differs from those illustrated by Sakai (2002, 2005), which themselves vary. The rostrum is strongly convex (fig. 4a; similar to that of the holotype of *M. indica*, but a female from the Andaman Sea appears much flatter), the fixed finger of the major cheliped of the new male has a concave tooth occupying the proximal half (fig. 4f; resembling that of the Indian female; the tooth is much shorter in a paratype male and little shorter in a paratype female), the propodus of pereopod 3 (fig. 4d) is not as strongly lobed as figured by Sakai, and the maxilliped 3 is much wider and with a squarer propodus than previously figured (fig. 4b, c). The strong thumb on the propodus of pereopod 4 (fig. 4e) has not been noted previously. Male pleopods 1 and 2 are similar to those of *M. indica* (fig. 4i, j; labels E and F are reversed on Sakai's (2002) fig. 14). The armature of the cheliped merus, the shapes of the uropod and the telson of the newly found specimen (fig. 4h) are essentially identical to that previously figured.

#### *Mocallichirus* Poore, Dworschak, Robles, Mantelatto and Felder, 2019

*Mocallichirus* Poore et al., 2019: 113.—Robles et al., 2020: figs 1, 4, 7, tables S1, S2.

*Remarks.* The genus was erected as part of a molecular and morphological review, distinguishing its only species from the larger genus *Neocallichirus* Sakai, 1988 (Poore et al., 2019; Robles et al., 2020).

#### *Mocallichirus mocambiquensis* (Sakai, 2004)

Figure 5

*Callianassa mocambiquensis* Sakai, 2004: 585–592, figs 15–17.—Sakai, 2005: 93.

*Trypaea mocambiquensis*.—Sakai, 2011: 404.

*Mocallichirus mocambiquensis*.—Poore et al., 2019: 146.—Robles et al., 2020.

*Material examined.* Holotype. Mozambique Channel, 26–28 m, MNHN Th1452 (male [somewhat shrivelled], 3.3 mm). Paratypes. Collected with holotype, MNHN Th1453 (3 males, 3.0 mm).

**Madagascar.** Nosy Bé, across bay from CNRO complex, off Lokobe Reserve, 13.4139° S, 48.3056° E, 1–3 m, seagrass (stn MGNW-23), UF 14337\* (female, 4.2 mm). Nosy Bé, E of Hellville, at CNRO complex, 13.4069° S, 48.2917° E, 0–3 m (stn MGNW-26), UF 13903 (female, 4.5 mm); (stn MGNW-49), UF 13986 (male, 4.5 mm); (stn MGNW-26), UF 14462 (female, 4.5 mm). Nosy Bé, Plante stn NM2, MNHN IU-2016-8087 (male, 7.5 mm). Nosy Bé, Faubert, 10 m, MNHN IU-2016-8088 (male, 9.8 mm).

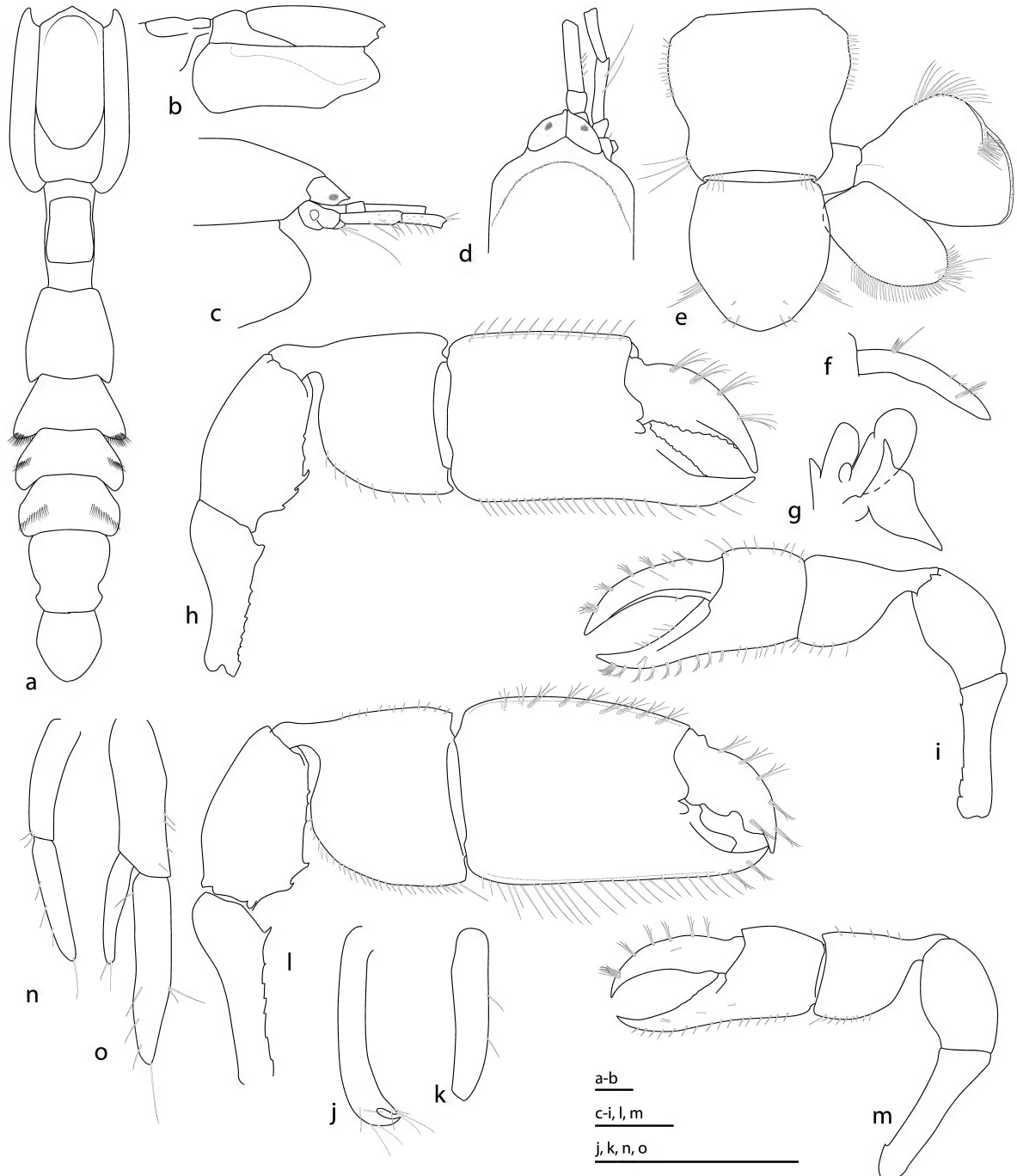


Figure 5. *Mocallichirus mocambiquensis* (Sakai, 2004). Madagascar. UF 13986, male, 4.5 mm: a, dorsal habitus; b, lateral carapace, pleonite 1; c, d, anterior carapace, eyestalks, antennular and antennal peduncles; e, pleonite 6, telson, right uropod; f, telson, left lateral view; g, maxilliped 1; h, major cheliped (left, mesial); i, minor cheliped (right, mesial); j, pleopod 1 (right); k, pleopod 2 (right, anterior view). UF 13903, female, 4.5 mm: l, major cheliped (left, mesial); m, minor cheliped (right, mesial). Scale bars = 1 mm.

**Supplementary description. Male.** Carapace quarter length of total; cervical groove at 0.8 length of carapace, well incised on dorsum; dorsal oval weak; cardiac pore present, without cardiac prominence. Rostrum broadly triangular, exceeding anterolateral lobes. Pleonite 1 with sclerified tergite not extending laterally, with shallow transverse groove; pleonite 2 1.3 times as long as pleonite 1 tergite; pleonites 3–5 expanded laterally with dense setose areas; pleonite 6 waisted posteriorly.

Eyestalk broader than long, basal height two-thirds length, lateral margin evenly convex, mesiodistal apex produced as acute lobe; cornea about 0.2 width, distolateral. Antennule 1.8 times basal width of both eyestalks, article 3 setose ventrolaterally. Antenna 2.1 times basal width of both eyestalks; scaphocerite absent. Maxilliped 1 with disc-like endopod, broad exopod, epipod with attenuated anterior lobe beyond lateral shoulder.

Major pereopod 1 (cheliped) ischium denticulate, distal tooth strongest; merus with 3 angled teeth over second quarter of lower margin; carpus waisted proximally; propodus upper margin carinate, 1.1 times as long as greatest width, with mesial edge produced and a tubercle at base of dactylus; fixed finger 0.6 times palm upper margin, cutting edge with denticulate lateral margin; dactylus as long as fixed finger, cutting edge with weakly crenellate lateral margin.

Minor pereopod 1 (cheliped) 0.7 times length of major; ischium weakly denticulate; merus lower margin smooth; carpus waisted proximally; propodus upper margin 0.85 times as long as greatest width, with mesial edge slightly produced at base of dactylus; fixed finger 1.3 times palm upper margin, cutting edge smooth; dactylus as long as fixed finger, cutting edge with weak tooth.

Pleopod 1 uniarticulate, curved, with oblique curved apical notch. Pleopod 2 uniarticulate, shorter than pleopod 1, tapering beyond greatest width at midpoint to oblique truncate apex, without appendices.

Uropod endopod 1.8 times as long as wide, with marginal setae, cluster of distal setae on upper face; exopod 1.5 times as wide as anterior margin, dorsal plate almost semicircular, well distinguished from distal margin, with few spiniform setae, posterodistal angle rounded.

Telson dorsally convex, 1.1 times as long as wide, lateral margins almost parallel over most of length, tapering over distal third to broadly rounded apex, with pair of clusters of distolateral setae but otherwise with few setae.

**Female.** Major pereopod 1 (cheliped) ischium as in male; merus with 2 angled teeth over second quarter of lower margin; carpus as in male; propodus upper margin carinate, 1.3 times as long as greatest width, with mesial edge produced and a tubercle at base of dactylus; fixed finger 0.3 times upper margin, cutting edge with strong step on lateral margin; dactylus as long as fixed finger, cutting edge with blunt basal tooth, notch, triangular tooth. Minor pereopod 1 essentially as in male.

Pleopod 1 with 2 articles, curved, article 2 with rounded apex. Pleopod 2 biramous; endopod 1.1 times length of peduncle, 5 times as long as wide, tapering to simple rounded apex, without appendix interna; exopod half as long as endopod.

**Size.** Cl. to 9.8 mm.

**Distribution.** Western Indian Ocean (Mozambique Channel [type locality], Madagascar); 1–28 m.

**Remarks.** Sakai (2011) included the species in *Trypaea*, a genus of Callianassidae s.s., in which he included more than 50 species. The epipod on maxilliped 1 (fig. 5g) and pleopods (fig. 5j, k, n, o) confirm its placement in Callichiridae, consistent with genetic affinities (Robles et al., 2020).

The species is immediately recognisable from the shape of the telson, appearing almost pentagonal, the lateral margins almost parallel over most of length and the posterior third tapering to a rounded obtuse apex, and convex in lateral view (fig. 4). Sakai's figure (2004, fig. 17E) of the telson of the somewhat shrivelled holotype is distorted and the chelipeds (Sakai, 2004: fig. 16A, B) are of a juvenile form. Sakai (2004) reported that the male holotype possessed a "two-segmented" pleopod 1 and lacked pleopod 2. A re-examination of the holotype revealed simple pleopods 1 and 2. Two of the three paratype males examined had no pleopods. All these are smaller (3.5 mm) than the male collected at Madagascar (4.5 mm), which has a 1-articled pleopod 1 with a distal notch (fig. 5j) and a simple pleopod 2 with a truncate apex (fig. 5k).

### ***Mucrollichirus* Poore, Dworschak, Robles, Mantelatto and Felder, 2019**

*Mucrollichirus* Poore et al., 2019: 113–114.—Robles et al., 2020.

**Remarks.** The genus was erected as part of a molecular and morphological review, distinguishing its only species from its larger sister genus *Corallianassa* (Poore et al., 2019; Robles et al., 2020). The type species had been placed in *Neocallichirus* Sakai, 1988, from which it appears far removed genetically. *Mucrollichirus* is notable for the weakly lobed propodus on pereopod 3 (fig. 6f), the short telson (fig. 6a, d) and the somewhat swollen propodus of the major cheliped (fig. 6g, m).

### ***Mucrollichirus mucronatus* (Strahl, 1862)**

Figure 6

*Callianassa mucronata* Strahl, 1862: 1056–1060.—De Man, 1888: 484–485, pl. 21 fig. 2 (record from Ambon).—Poore and Griffin, 1979: 273–275, figs 34, 35.

*Callianassa brevicaudata* A. Milne-Edwards, 1870: 91–92 (type locality, Zanzibar [Tanzania]).

*Neocallichirus mucronatus*.—Sakai, 1999: 105–107, fig. 26 (synonymy).—Sakai, 2011: 462–463 (full synonymy).—Sakai and Türkay, 2014: 185–187 (synonymy).—Dworschak, 2018: 31–36, figs 10, 11.

*Callianassa (Cheramus) novaeguineae* Thallwitz, 1891: 31–33, pl. 3 fig. 9 (type locality, Northwest Neu-Guinea (Indonesia)).

*Callianassa novaeguineae*.—De Man, 1902: 757–758.

*Callianassa (Callichirus) mucronata*.—De Man, 1928a: 175–179, pl. 19, figs 30–30e (record from Ambon).

*Mucrollichirus mucronatus*.—Poore et al., 2019: 144.—Robles et al., 2020: figs 1, 4, 7, tables S1, S2.

**Material examined.** **Djibouti and Perim**, coll. Dr Jousseume, 1897, det. G. Nobili, AM P.5387 (2 females, 7.2, 8.6 mm). **Madagascar**, Nosy Bé, lagoon S of CNRO, muddy coral, 13.416° S, 48.29044° E, 23–25 m, UF 13925 (female, 8.5 mm). **Papua New Guinea** (PAPUA NIUGINI stns). Madang Province. Sek I., 0–2 m, 05° 04.8' S, 145° 48.9' E (stn

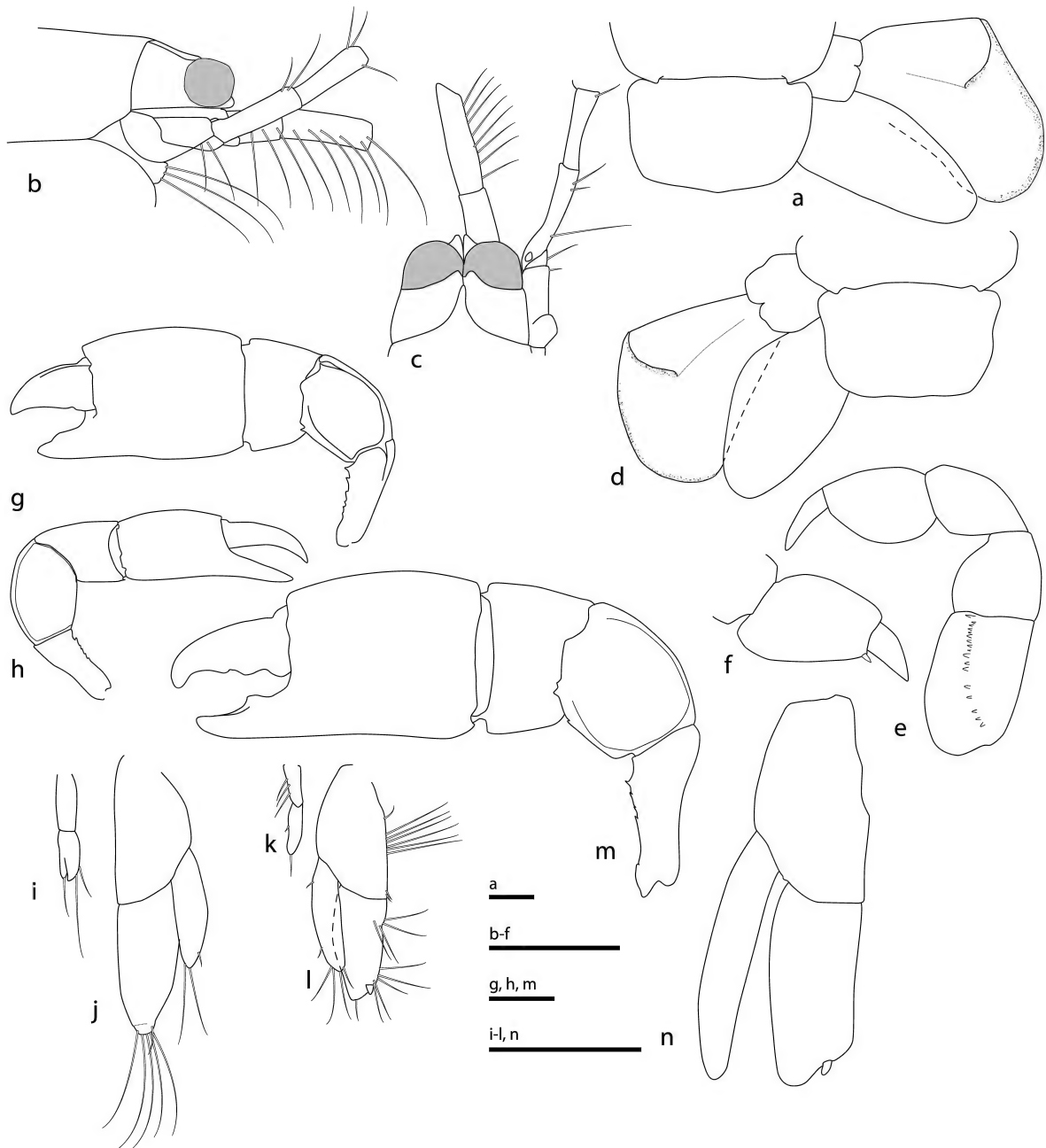


Figure 6. *Mucrollichirus mucronatus* (Strahl, 1862). Djibouti, AM P.5387, female, 8.6 mm: a, telson, uropod. Papua New Guinea, male, 2.5 mm, MNHN IU-2014-2777: b, c, anterior carapace, eyestalks, antennular peduncle, antennal peduncle; d, telson, uropod; e, maxilliped 3; f, pereopod 3 propodus, dactylus; g, major cheliped (right, mesial view); h, minor cheliped (left, mesial view); i, j, pleopods 1, 2. Papua New Guinea, MNHN IU-2014-1067, male, 4.0 mm: k, l, pleopods 1, 2. Papua New Guinea, MNHN IU-2014-459, female, 9.8 mm: m, major cheliped (right, mesial view); n, pleopod 2. Scale bars = 1 mm.

PR26) MNHN IU-2013-558 (female, 5.6 mm); Rempy area, E of Dumduman I., 2–13 m, 05° 01.18' S, 145° 48.0' E (stn PR63) MNHN IU-2013-7099 (ovigerous female, 3.0 mm). New Ireland. E side of Globig I., coral rubble with algae, sand, 3–5 m, 02° 38.8' S, 150° 44.2' E (stn KZ21), MNHN IU-2014-1067 (male, 4.0 mm); Cape Sueusat, coral drop off, 6–12 m, 02° 37' S, 150° 46.3' E (stn KZ06), MNHN IU-2014-2480\* (female, 5.0 mm); Kavieng Lagoon, Byron Channel, SE Patio I., rubble slope, 2–7 m, 02° 36.6' S, 150° 32.9' E (stn KB40), MNHN IU-2014-2576\* (female, 9.8 mm); NW side of Ral I., 19 m, 02° 36.4' S, 150° 42.4' E (stn KB62), MNHN IU-2014-2776\* (lost), MNHN IU-2014-2777\* (male, 2.5 mm). **Australia**, Qld, Rat I, AM P.2010 (male, 8.0 mm); Palm I., AM P.5194 (female, 10.1 mm). WA, S end of Ashmore Reef, 12° 16.7385' S, 122° 59.088' E, WAM C54241 (2 females).

*Size.* Cl. to 10.3 mm.

*Distribution.* Western and Central Indo-Pacific. The species has been widely reported from the Philippines (type locality: Luzon) (Dworschak, 1992, 2018), Indonesia (De Man, 1928a), Papua New Guinea, Maldives (Ortmann, 1894), north Queensland, Australia (Poore and Griffin, 1979), Djibouti and Madagascar (Sakai, 1999), and the Red Sea (Sakai et al., 2014). The identity of the specimens from Australia was confirmed as part of this study.

*Remarks.* Strahl (1862) reported on one female of *C. mucronata* of 13 lines (27.5 mm) without chelipeds from Luzon, Philippines, but supplemented his description with mention of a second smaller one of about 5 lines (10.6 mm). Tirmizi (1977) redescribed the larger one (ZMB 1128) as the holotype without noting the presence of a second specimen; this is an effective lectotype designation (ICZN Article 74.5). Sakai (1999) examined both specimens and alleged that Tirmizi's fig. 1B of the front of the carapace, eyestalks and antennules and antennae was of the smaller specimen. As argued by Dworschak (2018), this is improbable. The scale bars provided by Tirmizi (1977) and by Sakai (1999) indicate that the front of the carapace is about 4 mm wide. Tirmizi's fig. 1A of the dorsal habitus, fig. 1B of the front, and Sakai's fig. 26a of the front are all from the lectotype (called holotype by both authors). Sakai (1999: 44–46, fig. 8) described the smaller specimen (ZMB 27222) as *Callianassa gruneri* Sakai, 1999. The figure suggests that the fragments came from more than one species, and Poore et al. (2019) listed *C. gruneri* as incerta sedis.

The syntypes of *C. novaeguineae* were collected in “Nordwest Neu-Guinea” (now West Papua Province or Papua Province, Indonesia) and comprise a fairly well-preserved specimen of total length c. 40 mm and broken pieces of a smaller one. They were lodged in MTKD but were probably destroyed during World War II. De Man (1902) redescribed the entire syntype and suspected the species to be synonymous with *C. mucronata*. He later treated them as synonyms and redescribed and reillustrated material from Ambon, Indonesia (De Man, 1928a), specimens that he had previously identified as *C. mucronata* (De Man, 1888). Both names were included as synonyms and transferred to *Neocallichirus* by Sakai (1999) and later authors.

The male pleopods have not previously been illustrated, except for the tip of the endopod (Sakai, 1999: fig. 26i). Sakai (1999) described pleopod 1 as of two articles, the second one

“chelate”. In two small males from Papua New Guinea, pleopod 1 has two articles, the second article of one male with a deep apical longitudinal slit (fig. 6l, k). Pleopod 2 is biramous; an appendix interna is obvious in one small male (fig. 5j, l). The female pleopod 1 is of two articles (De Man, 1928a: pl. 19 fig. 30e; Tirmizi, 1977: fig. 3B; Dworschak, 2018: fig. 10c), typical of callichirids, not three as stated by Sakai (1999). The female pleopod 2 has a broad endopod with an obliquely truncate apex, with a small appendix interna (fig. 5n; see too Tirmizi, 1977: fig. 3C; Dworschak, 2018: fig. 10f, g).

Molecular data found no genetic divergence between Philippines and Papua New Guinea populations identifiable as *M. mucronatus* (Robles et al., 2020). Morphological differences are slight. De Man (1928a) noted that the posterior border of the uropodal endopod of his specimens from Ambon is regularly rounded (De Man, 1888: pl. 19 fig. 2a) while in the type of *C. mucronata* it appears obtusely angular in the middle. He believed that “this slight difference is no doubt individual”. Tirmizi's (1977: fig. 1C) and Sakai's (1999: fig. 26c) figures show this margin to be evenly curved, as in the new material from Papua New Guinea (fig. 5d). Another from Djibouti was found to have narrower uropodal rami than typical individuals (fig. 6a). Revival from synonymy of *Callianassa novaeguineae* cannot be justified.

### *Neocallichirus* Sakai, 1988

*Remarks.* *Neocallichirus* is the largest of the 17 genera of Callichiridae (Poore et al., 2019). It comprises 33 nominal accepted species (DecaNet eds, 2023) of which about half occur in the Indo-West Pacific and 14 in the Caribbean and Atlantic. Sakai's (2011) key to species is now incomplete and includes species now in other genera; Hernández et al. (2020) provided a key to seven Western Atlantic species. Species of *Neocallichirus* are recognised by the uropodal endopod with a straight or slightly convex anterior margin ending in a rounded angle, the posterior margin being more or less continuous with the posterior margin, a telson that tapers regularly to about half its width, and the antennal peduncle being longer than the antennular peduncle. Some of the nominal Indo-West Pacific species are incompletely described and problematic for one reason or another. Most were described from one or few specimens, or incomplete specimens, some possibly from juveniles. The types of some species have been illustrated more than once, e.g. *Neocallichirus moluccensis* (De Man, 1905) (De Man, 1928a; Kazmi and Kazmi, 1992; Sakai, 1999) but inconsistencies between figures such as these suggest that subtle differences between species are masked. Variation is appreciable for three species that have been collected in sufficient numbers (Dworschak, 2011a, 2011b, 2018) which, if accepted, would appear to allow other nominal species to be synonymised.

The diagnoses and key to 15 Indo-West Pacific species below rely on direct observations of seven species and published illustrations of the others. Some are difficult to distinguish in isolation. Five nominal species deserve comment and are not included in the key:

*Neocallichirus auchenorhynchus* Sakai, 2005 is based on a single very small female (cl. 4.4 mm) from an unknown locality. Sakai's (2005) description of the “frontal margin of carapace showing a neck-like form, with triangular rostrum and a pair of

anterolateral projections” (Sakai, 2005: fig. 37A) is hard to credit because the figure of the lateral view (Sakai, 2005: fig. 37B) does not show this and is typical of all callichirids. Lack of a type locality, small size, absence of the major cheliped and suspect illustrations argue for treating this name as species inquirenda.

*Neocallichirus kenyaensis* Sakai, 2015, is an unavailable name, without an explicit holotype, thereby failing ICZN Articles 16.4 and 72.3. The name was suggested for the female from Kenya identified by Dworschak (2011b) as *N. natalensis* (Barnard, 1947). The blade on the lower margin of the major cheliped is more developed on this 117-mm-long individual (Dworschak, 2011b, fig. 5E, F) than in the 100-mm-long holotype (Barnard, 1950: fig. 95g; Sakai, 2015: fig. 23c) but the dactylus is identical. A new name is not needed. *Callianassa natalensis* Barnard, 1947 was synonymised with *N. indicus* but Dworschak (2011b) showed it to be valid. *Neocallichirus indicus* is a synonym of *jousseauiei* Dworschak (2011b, 2018).

*Neocallichirus pola* Sakai and Türkay, 2014, type locality, Red Sea, seems indistinguishable from *N. mauritanus* (Miers, 1882) known only from Mauritius. If synonymous, the distribution of *N. mauritanus* would be extended (see below).

Poore et al. (2019) synonymised *Callichiropsis* Sakai, 2010 with *Neocallichirus*. Its only species *C. spiridonovi* Sakai, 2010 was included by these authors in *Neocallichirus*, but was based on two small damaged females with major chelipeds too difficult to characterise.

Dworschak (2011b) found no morphological difference between *Callianassa (Cheramus) variabilis* Edmondson, 1944 from Hawaii and *N. jousseauiei*, despite unpublished molecular studies that he cited showing a sufficient specific difference. The most recent molecular data, possibly using different genes, found almost no genetic difference between individuals of “*N. jousseauiei*” from Hawaii and Cocos (Keeling) Is relative to differences between individuals from Philippines, Papua New Guinea and Iran (Robles et al., 2020). While this uncertainty remains, *Neocallichirus variabilis* (Edmondson, 1944) is not included in the key to species below.

### Key Indo-West Pacific and Australian species of *Neocallichirus*

1. Uropodal endopod 1.3 times as long as wide, posterior margin decidedly oblique, angle with anterior margin about 40° ..... 2
  - Uropodal endopod about as long as wide or wider than long, posterior margin moderately oblique or transverse, rounded angle between it and anterior margin ..... 3
2. Carapace anterolateral lobes acute. Maxilliped 3 propodus with slightly oblique concave transverse distal margin. Telson tapering from base to continuous rounded posterolateral margin. Major cheliped merus lower margin with straight dentate blade except over distal quarter ..... *N. vigilax*
  - Carapace anterolateral lobes rounded. Maxilliped 3 propodus disto-lower margin evenly rounded. Telson clearly tapering from greatest width at midpoint. Major cheliped merus lower margin with proximal tooth, square in male, triangular in female ..... *N. mauritanus*
3. Cornea reduced to small pigment spot ..... *N. darwinensis*
  - Cornea prominent, pigmented ..... 4
4. Eyestalk distal lobe with truncate margin, usually with 1 or more denticles ..... 5
  - Eyestalk distal lobe rounded or acute, not denticulate ..... 8
5. Major cheliped merus twice as long as wide, evenly convex, smooth; palm shorter than carpus; dactylus cutting edge with 2 obscure teeth. Minor cheliped subequal to major ..... *N. manningi*
  - Major cheliped merus 1.2–1.7 times as long as wide, with dentate blade; palm as long as or longer than carpus; dactylus cutting edge entire or with concave proximal rectangular tooth over most of length, distal triangular tooth. Minor cheliped narrower than major cheliped palm, palm shorter than carpus ..... 6
6. Major cheliped merus 1.2–1.5 times as long as wide, lower margin with asymmetrically curved blade, widest and denticulate over proximal half, more prominent in adult ..... *N. jousseauiei*
  - Major cheliped merus 1.5–1.7 times as long as wide, lower margin straight, dentate or denticulate ..... 7
7. Major cheliped merus with narrow straight dentate blade over proximal three-quarters; dactylus cutting edge entire. Minor cheliped palm about half as wide as major cheliped palm; palm longer than carpus. Maxilliped 3 propodus disto-lower margin evenly rounded. Telson tapering from subproximal width to continuous rounded posterolateral margin ..... *N. darvishi*
  - Major cheliped merus with wide rectangular dentate blade over proximal three quarters, margin straight or gently convex; dactylus cutting edge with molar-like tooth near midpoint, deep notch, concave blade over distal half. Minor cheliped palm about two-thirds as wide as major cheliped palm, shorter than carpus. Maxilliped 3 propodus transverse margin slightly oblique, concave. Telson clearly tapering from subproximal width to rounded corner between well-defined posterolateral margin and convex-straight posterior margin ..... *N. natalensis*
8. Major cheliped merus lower margin with asymmetrical dentate blade, prominent proximally, tapering distally ... 9
  - Major cheliped merus lower margin evenly convex or with straight dentate blade ..... 10
9. Major cheliped merus lower margin with asymmetrically curved blade, widest and dentate over proximal half, margin concave over distal third. Minor cheliped palm about half as wide as major cheliped palm, longer than carpus. Pereopod 3 propodus with proximally directed lobe of lower margin clearly protruding beyond lower margin of carpus. Female pleopod 2 appendix interna digitiform, subdistal, reaching or overlapping end of endopod ..... *N. calmani*

- Major cheliped merus lower margin with triangular blade tapering distally, more strongly dentate proximally. Minor cheliped palm about one-third as wide as major cheliped palm, shorter than carpus. Pereopod 3 propodus with proximally directed lobe of lower margin aligned with lower margin of carpus. Female pleopod 2 appendix interna digitiform, terminal ..... *N. frouini*
- 10. Eystalk distal lobe elongate, longer than precorneal length, distally tapering, transparent ..... *N. vaugelasii*
- Eystalk distal lobe shorter than precorneal length, distally acute, rounded or truncate ..... 11
- 11. Eystalk distal lobe rounded, not differentiated from eystalk proper. Antenna peduncle as long as antennule peduncle ..... *N. angelikae*
- Eystalk distal lobe rounded, not differentiated from eystalk proper. Antenna peduncle longer than antennule peduncle ..... 12
- 12. Major cheliped merus about 1.6 times as long as wide ..... 13
- Major cheliped merus at least twice as long as wide ..... 14
- 13. Maxilliped 3 propodus lower margin evenly rounded. Uropodal endopod posterior margin decidedly oblique, curving continuously to convex anterior margin. Telson tapering from base to continuous rounded posterolateral margin ..... *N. taiaro*
- Maxilliped 3 propodus distal margin transverse. Uropodal endopod posterior margin moderately oblique, angle with anterior margin about 30°. Telson clearly tapering from subproximal width to rounded corner between well-defined posterolateral margin and convex-straight posterior margin ..... *N. horneri*
- 14. Anterior lobe of eystalk truncate, with sharp distolateral angle. Telson clearly tapering from subproximal width to rounded corner between well separated posterolateral and posterior margins ..... *N. moluccensis*
- Anterior lobe of eystalk rounded, triangular. Telson scarcely tapering from subproximal width to rounded posterolateral-posterior margin ..... *N. nagoi* sp. nov.

### *Neocallichirus angelikae* Sakai, 2000

#### Figure 7

*Neocallichirus angelikae* Sakai, 2000: 92–97, figs 1–3.—Sakai, 2005: 176.—Sakai, 2011: 453.

**Material examined.** **Australia**, SA, Long Beach, Coffin Bay, 34.62° S, 135.45° E, NMV J59652 (3 males, 6 females, 14–20 mm).

**Diagnosis.** Carapace anterolateral lobe acute, small. Antenna peduncle as long as antennule peduncle. Eystalk distal lobes rounded, not differentiated from eystalk proper. Major cheliped merus lower margin with narrow straight dentate blade over proximal three-quarters; palm tuberculate on lateral and distal mesial faces in larger individuals; fixed finger cutting edge concave, denticulate over proximal half; dactylus cutting edge with notch at midpoint (male). Uropodal endopod posterior margin decidedly oblique, curving continuously to convex anterior margin. Telson clearly tapering from subproximal width to rounded corner between well-defined posterolateral margin and convex-straight posterior margin. Maximum cl. 20 mm.

**Distribution.** Southwestern Australian Shelf (Australia, SA [type locality: Ceduna]).

**Remarks.** Sakai (2000) based *N. angelikae* on a single small individual said to be a female. The pleopod 1 illustrated (Sakai, 2000, fig. 3G) is from a male; pleopod 2 (fig. 3H) shows two endopodal articles with a small appendix interna, an arrangement not seen elsewhere in the genus. Here, male and female pleopods 1 and 2 are figured from a collection of larger individuals collected near the type locality (fig. 7b–e). Pereopod 3 is illustrated for the first time (fig. 7a).

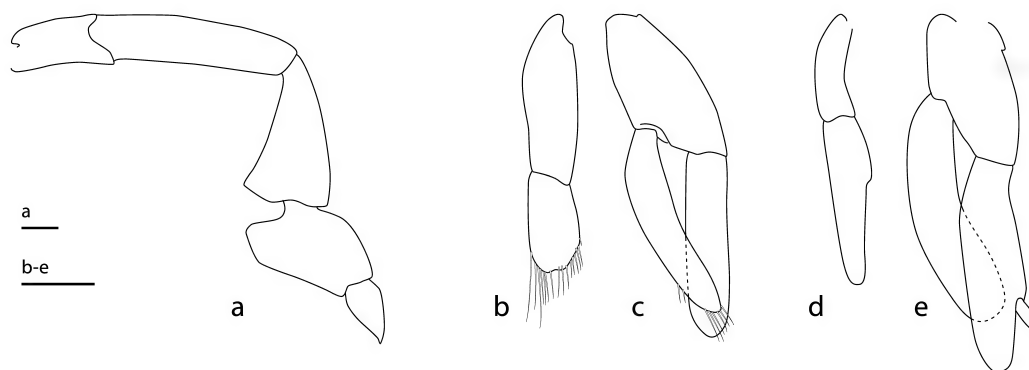


Figure 7. *Neocallichirus angelikae* Sakai, 2000. Australia, SA. NMV J59652, male, 14 mm: a, pereopod 3; b, c, pleopods 1, 2; female, 20 mm: d, e, pleopods 1, 2. Scale bars = 1 mm.

***Neocallichirus calmani* (Nobili, 1904)**

Figure 8

*Callianassa* (*Cheramus*) *calmani* Nobili, 1904: 237.—Nobili, 1906: 104–15, pl. 5 fig. 2.

*Callichirus calmani*.—de Saint Laurent and Le Loeuff, 1979: 97.

*Callianassa calmani*.—Dworschak, 1992: 192, fig. 3.

*Neocallichirus calmani*.—Sakai, 1999: 96–98, fig. 22a–d.—Sakai, 2011: 455.—Dworschak, 2018: 27–31, figs 6–9 (redescription, synonymy).—Poore et al., 2019: 145.—Robles et al., 2020.

**Material examined.** **Jordan**, Al Aqaba, Red Sea, in front of Holiday Inn, NMV J55684 (ex MHNH) (male, 15.1 mm; female, 13.5 mm). **USA**, Mariana Is, Guam, Apra Harbour, tip of Glass Breakwater, 13.45473° N, 144.62547° E, reef slope in outer lagoon, UF 29713 (female, 7.5 mm), UF 29715 (female, 6.5 mm); W coast, near War in the Pacific Park, 13.5° N, 144.8° E, seagrass, UF 27333 (male, 8.2 mm), UF 29709 (male, 18.1 mm), UF 29711 (female, 14.1 mm), UF 29714 (male, 11.4 mm). **Australia**, Qld, Lizard I., Lumus beach, silty reef, soft and hard corals, UF 17052 (female, 5.76 mm), UF 17152 (female, 28.8 mm), UF 16888 (male, 11.7 mm), UF 17002 (female, 27.2 mm), UF 17003 (female, 25.6 mm); Lizard I., Watson's Bay, 14.664° S, 145.4513° E, UF 17241 (female, 27.6 mm). WA, Bernier I., beach S of Wedge Point, WAM C11999 (female, 21 mm). **Kiribati** (Gilbert Is), Arorae I., 2° 38' S, 176° 52' E, AM P.102701 (female, 16 mm). **French Polynesia**, Moorea, Papetoai, 17.49° S, 149.88498° W (stn BIZ-548), UF 29095\* (female, 7.7 mm). Shallow bay between Gump and Nihimaru, 17.4933° S, 149.8793° W (stn MIB171), UF16198 (female, 5.2), UF 16199 (male, 4.6 mm).

**Diagnosis.** Antenna peduncle exceeding antennule peduncle by half of article 5. Eyestalk distal lobes triangular, rounded, diverging. Major cheliped merus lower margin with asymmetrically curved blade, widest and dentate over proximal half, margin concave over distal third; gape with molar-like tooth in male; fixed finger cutting edge concave, denticulate over

proximal half, or smooth; dactylus cutting edge with tooth (often molar-like) one-third way along, separated by notch from distal blade (female), or with tooth (often molar-like) one-third way along, distal half smooth (male). Pereopod 3 propodus with proximally directed lobe of lower margin protruding beyond lower margin of carpus. Uropodal endopod posterior margin moderately oblique, angle with anterior margin about 30°. Telson tapering from base to continuous rounded posterolateral margin. Maximum cl. 28.8 mm.

**Type locality.** Obock, Djibouti.

**Distribution.** Western, Central and Eastern Indo-Pacific (Saudi Arabia, Red Sea, Madagascar, Indonesia, Philippines, Vietnam, Mariana Is, Kiribati, French Polynesia, NE Australia).

**Remarks.** Dworschak (2018) redescribed *Neocallichirus calmani* in detail. The species is distinguished from congeneric species by the asymmetrically curved blade on the major cheliped merus, widest and dentate over the proximal half, the molar-like tooth in the gape of the male cheliped, and the strong dorsal curvature of the telson.

On the basis of molecular data, Robles et al. (2020) found one of three individuals collected in French Polynesia to be sister to another identified as *N. calmani* from Iran, close to the type locality. This small female lacks ornamentation on the cheliped merus and has sharp teeth along the margins of the cheliped (fig. 8f). This record and another from Kiribati extend the geographic range of *N. calmani* from throughout the Indian Ocean into the eastern Indo-West Pacific. The only other species of *Neocallichirus* recorded from French Polynesia is *N. taiaro*. Individuals from Queensland, Australia, are about twice as long as all others but could not be distinguished otherwise.

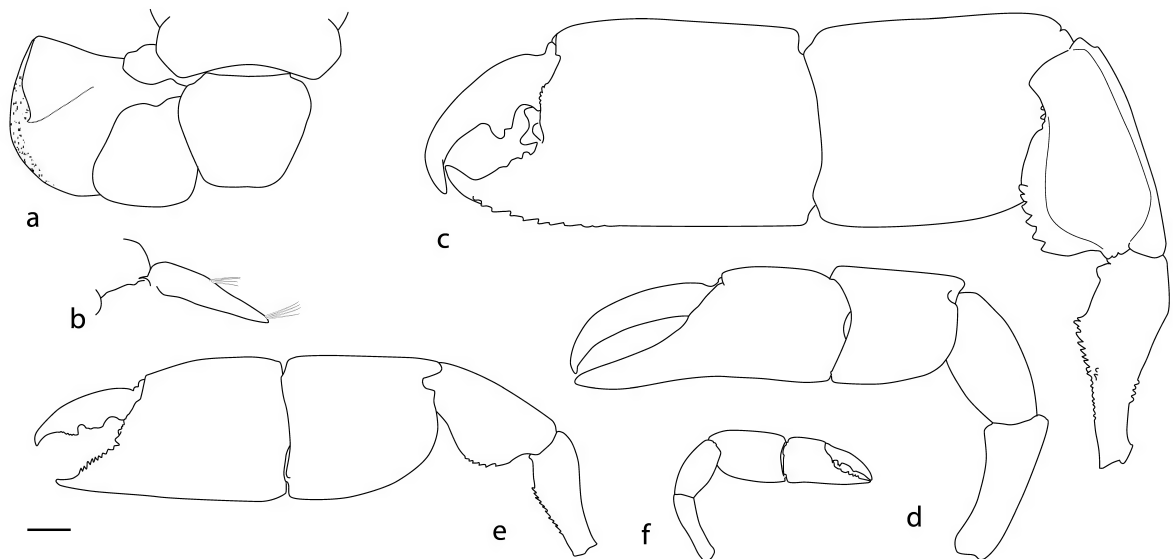


Figure 8. *Neocallichirus calmani* (Nobili, 1904). Jordan, Red Sea. NMV J55684, male, 15.1 mm: a, telson, uropod; b, telson, lateral view; c, major cheliped (right, mesial); d, minor cheliped (left, lateral); female, 13.5 mm: e, major cheliped (left, lateral). French Polynesia, UF 29095, female, 7.7 mm: f, major cheliped (left, mesial). Scale bar = 2 mm.



***Neocallichirus darvishi* Sepahvand, Komai, Momtazi and Shahabi, 2018**

*Neocallichirus darvishi* Sepahvand et al., 2018: 241–247, figs 1–4.

**Diagnosis.** Antenna peduncle exceeding antennule peduncle by one-third of article 5. Eyestalk distal lobes tapered, often truncate, with denticulate distal margin. Major cheliped merus lower margin with narrow straight dentate blade over proximal three-quarters; gape simple; fixed finger cutting edge smooth; dactylus cutting edge with molar-like tooth in proximal half, separated by deep notch from broad subtriangular tooth distally. Uropodal endopod posterior margin decidedly oblique, curving continuously to convex anterior margin. Telson tapering from base to continuous rounded posterolateral margin. Maximum cl. 8.2 mm.

**Distribution.** Somali/Arabian (known only from type locality: Persian Gulf, Iran).

**Remarks.** The species has not been recorded since its description.

***Neocallichirus darwinensis* Sakai, 1988**

Figure 9a, b

*Neocallichirus darwinensis* Sakai, 1988: 62–65, figs 5, 6.—Sakai, 2011: 455 (synonymy).

*Neocallichirus caechabitor* Sakai, 1988: 67–68, figs 9, 10.—Sakai, 1999: 96.—Davie, 2002: 461.—Sakai, 2011: 454–455 (type locality, Australia, NT, Darwin). **Syn. nov.**

**Material examined.** **Australia**, NT, Mindi Beach, NTMAG Cr000090 (holotype female, 24 mm).

**Diagnosis.** Antenna peduncle exceeding antennule peduncle by all of article 5. Cornea reduced to small pigmented area; eyestalk distal lobes truncate, with distolateral sharp corner. Uropodal endopod posterior margin moderately oblique, angle with anterior margin about 30°. Telson clearly tapering from subproximal width to rounded corner between well-defined

posterolateral margin and convex-straight posterior margin. Maximum cl. 24 mm.

**Distribution.** Sahul Shelf (Australia, NT [type locality: Darwin]).

**Remarks.** *Neocallichirus darwinensis* Sakai, 1988 was taken in the same region as *N. caechabitor* Sakai, 1988, and *N. horneri* Sakai, 1988, type species of the genus. The female holotype, the only specimen known, lacks the major cheliped, and is 2.7 times as long as the type and only specimen of *N. caechabitor* (24 mm vs 9 mm). Both specimens are unusual in having reduced cornea; they have almost identical maxilliped 3, pereopod 3 and telson. The minor cheliped of *N. caechabitor* is narrower than that of *N. darwinensis*, but this may be a sex-related difference. Sakai (1988) stated the holotype of *N. caechabitor* is an immature female but figured immature male pleopods 1 and 2. The minor cheliped of males is narrower than that of females in *N. grandimana* (Gibbes, 1850) (Felder and Manning, 1995; Ayón-Parente et al., 2014) and in *N. mericeae* (Manning and Felder, 1995), and is narrow in juveniles, e.g. *N. sulfureus* (Lemaître and Felder, 1996). This may be true for all species of *Neocallichirus*, but both sexes and a wide size range have been illustrated for few species. *Neocallichirus caechabitor* is here synonymised with *N. darwinensis*.

*Neocallichirus darwinensis* is also twice as long as the types of *N. horneri*. *Neocallichirus horneri* has a fully developed cornea but some differences between the two species noted by Sakai (1988) may also be size-related. The antenna is relatively longer than the antennule in *N. darwinensis* than it is in *N. horneri*, and the propodus and dactylus of *N. darwinensis* are narrower than those of *N. horneri* (cf. fig. 9b, d). The uropodal endopod exopod of *N. darwinensis* is almost semicircular, whereas that of *N. horneri* is fan-shaped (cf. fig. 9a, c). Some of these differences fall within the variability seen in other species of *Neocallichirus* (Dworschak, 2008, 2011a, 2011b, 2018) but without more specimens the synonymy of these species is uncertain. All species are known only from type specimens.

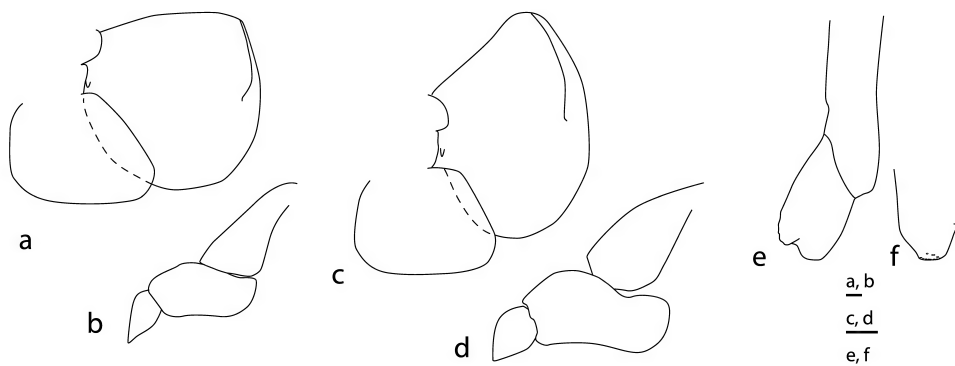


Figure 9. *Neocallichirus darwinensis* Sakai, 1988. Australia, NT, NTMAG Cr000090, holotype female, 24 mm: a, right uropod; b, pereopod 3, carpus–dactylus. *Neocallichirus horneri* Sakai, 1988, NTMAG Cr2048, paratype male, 14 mm: c, right uropod; d, pereopod 3, carpus–dactylus; e, pleopod 1; f, apex of pleopod 2. Scale bars = 1 mm.

***Neocallichirus frouini* Ngoc-Ho, 2005**

*Neocallichirus frouini* Ngoc-Ho, 2005: 74–77, fig. 14.

**Diagnosis.** Antenna peduncle exceeding antennule peduncle by half of article 5. Eyestalk distal lobes triangular, rounded, diverging. Major cheliped merus lower margin with triangular blade tapering distally, more strongly dentate proximally; gape with shallow notch; fixed finger cutting edge smooth; dactylus cutting edge with notch at midpoint (male). Uropodal endopod posterior margin moderately oblique, angle with anterior margin about 30°. Telson tapering from base to continuous rounded posterolateral margin. Maximum cl. 5.3 mm.

**Distribution.** Southeast Polynesia (known only from type locality: French Polynesia, Tahiti).

**Remarks.** The species has not been recorded since its description.

***Neocallichirus horneri* Sakai, 1988**

Figure 9c–f

*Neocallichirus horneri* Sakai, 1988: 65–66, figs 7, 8.—Sakai, 2011: 458 (synonymy).

**Material examined.** **Australia**, NT, Nightcliff, NTMAG Cr000846 (holotype female, 13 mm). West Shoal Bay, NTMAG Cr2048 (paratype male, 14 mm).

**Diagnosis.** Antenna peduncle exceeding antennule peduncle by one-third of article 5. Eyestalk distal lobes triangular, rounded, diverging. Major cheliped merus lower margin evenly convex, smooth (female); gape simple; fixed finger cutting edge denticulate over most of length; dactylus cutting edge with tooth (often molar-like) one-third way along, separated by notch from distal blade (female). Pereopod 3 propodus with proximally directed lobe of lower margin clearly protruding beyond lower margin of carpus. Uropodal endopod posterior margin moderately oblique, angle with anterior margin about 30°. Telson clearly tapering from subproximal width to rounded corner between well-defined posterolateral margin and convex-straight posterior margin. Maximum cl. 14 mm.

**Distribution.** Sahul Shelf (known only from type locality: Australia, NT, Darwin).

**Remarks.** Sakai's (1988) observations of the type specimens were confirmed by re-examination. The male paratype has a simply notched pleopod 1 apex and is a juvenile (fig. 9e; adults in this genus have a deeply notched apex), as is the female of similar size. Sakai (1988) likened the species to *N. indica* (now *N. jousseaumei*) noting the absence of denticles on the lobe of the eyestalk. These are absent in juveniles. The propodus of pereopod 3 does not align with the lower margin of the carpus as it does in *N. jousseaumei* (cf. fig. 9d with Dworschak, 2011b figures). Sakai (1988) did not compare *N. horneri* with *N. calmani*, a common and widespread Indo-West Pacific species with many similarities (see Dworschak, 2018). The propodus of maxilliped 3 is wider and more rectangular in *N. horneri*, but without adult chelipeds few further differences can be identified. The species is known only from types.

***Neocallichirus jousseaumei* (Nobili, 1904)**

*Callianassa* (*Cheramus*) *jousseaumei* Nobili, 1904: 236–237.

*Callianassa* (*Cheramus*) *indica* De Man, 1905: 605 (type locality, Indonesia, Bay of Kankmaralin, S coast of Kangean).

*Neocallichirus indicus*.—Sakai, 1999: 99, fig. 23a, b, d, e (lectotype, not fig. 23c).—Sakai, 2005: 178–179.—Sakai, 2011: 458.

*Neocallichirus jousseaumei*.—Sakai, 1999: 100–101, fig. 22e–g.—Sakai, 2011: 458–459 (synonymy).—Dworschak, 2011b: 2–9, figs 1–4, 6F–H (lectotype designation, redescription, synonymy).—Dworschak, 2014: 232–233, fig. 10b.—Dworschak, 2018: 25–27 (synonymy).—Poore et al., 2019: 145.—Robles et al., 2020.—Padate et al., 2022: 198 (list).

**Material examined.** **Saudi Arabia**, Red Sea, Al Lith, 20.167155° N, 40.223307° E (stn SAFA-039), UF 37166 (female, 7 mm). **Oman**, Muscat, UF 5439 (female, 6.5 mm). **Papua New Guinea**, Madang lagoon, 05° 11.5' S, 145° 49.5' E (stn PR58), MNHN IU-2013-7044 (male, 8.9 mm). Riwo, 05° 09' S, 145° 48.2' E, 1–2 m (stn PR235), MNHN IU-2013-7039\* (female, 9.3 mm); MNHN IU-2013-7122\* (male, 4.3 mm).

**Diagnosis.** Antenna peduncle exceeding antennule peduncle by half of article 5. Cornea prominent, hemispherical (sometimes with extracorneal pigment); eyestalk distal lobes tapered, often truncate, with denticulate distal margin. Major cheliped merus lower margin with asymmetrically curved blade, widest and denticulate over proximal half, more prominent in adult; gape with molar-like tooth in male; fixed finger cutting edge smooth, or with low proximal tubercles; dactylus cutting edge with molar-like tooth near midpoint, deep notch, concave blade over distal half, or entire. Uropodal endopod posterior margin almost transverse, angle with anterior margin squarish. Telson clearly tapering from subproximal width to rounded corner between well-defined posterolateral margin and convex-straight posterior margin. Maximum cl. 25.6 mm.

**Distribution.** Western and Central Indo-Pacific (Saudi Arabia; Oman; Yemen; Red Sea [type locality: Djibouti, Périm]; Persian Gulf; India; Australia, Cocos (Keeling) Is; Indonesia; Papua New Guinea; Japan, Ryuku Is; Thailand; Philippines).

**Remarks.** The species has a long and complicated synonymy, but its identity was well established by Dworschak (2011b), who described and illustrated several specimens, including type material from Djibouti. The species is notable for the denticulate lobe on the eyestalk, and the major cheliped merus with an almost evenly convex denticulate blade widest about one-third way along.

Sakai (1999, 2005, 2011) listed *N. indicus* as a valid species, but Dworschak (2011b, 2018) treated *C. (Cheramus) indica* De Man, 1905 as a junior synonym of *N. jousseaumei*. He recorded the species from the Red Sea, Persian Gulf, Indonesia, Philippines, Thailand and Cocos (Keeling) Is (Australia). He also recorded the species from French Polynesia as junior synonym *Callianassa taiaro* Ngoc-Ho, 1995, following Sakai's (1999) synonymy of this species with *N. indicus* (De Man, 1905). Padate et al. (2022) added India to the distribution.

Dworschak (2011b) argued that *Callianassa natalensis* Barnard, 1947, *C. manningi* Kazmi and Kazmi, 1992, and *C. variabilis* Edmondson, 1944, also synonymised with *N. indicus* by Sakai (1999), are valid species.

*Neocallichirus taiaro* Ngoc-Ho, 1995 has been treated as a synonym of *N. indicus* or *N. jousseaumei* (Sakai, 1999; Dworschak, 2011b) but the shape of the eyestalk, chelipeds, female pleopod 2, uropod and telson fall outside the variability of the latter. None of the specimens of *Neocallichirus* from French Polynesia seen during this study could be identified as *N. taiaro* or *N. jousseaumei*.

Molecular data does not distinguish Papua New Guinea and Philippines representatives (Robles et al., 2020). The juvenile male (MNHN IU-2013-7122) has swollen eyestalks terminating in a typical truncate lobe but lacks pleopod 1, and has a biramous but simple pleopod 2. The uropodal endopod is narrower than in typical *N. jousseaumei*. Molecular data suggest it is very close to this species (Robles et al., 2020), but is too small to characterise.

### *Neocallichirus manningi* Kazmi and Kazmi, 1992

*Neocallichirus manningi* Kazmi and Kazmi, 1992: 296, fig. 1.—Sakai, 2011: 460.—Sepahvand et al., 2018: 247–251, figs 5–7.

*Neocallichirus indicus*.—Sakai, 1999: 99.

**Diagnosis.** Antenna peduncle exceeding antennule peduncle by one-third of article 5. Eyestalk distal lobes tapered, often truncate, with denticulate distal margin. Major cheliped merus lower margin evenly convex, smooth (female); gape simple; fixed finger cutting edge denticulate over most of length; dactylus cutting edge with 2 obscure teeth (female). Uropodal endopod posterior margin decidedly oblique, curving continuously to convex anterior margin. Telson clearly tapering from subproximal width to rounded corner between well-defined posterolateral margin and convex-straight posterior margin. Maximum cl. 9 mm.

**Distribution.** Somali/Arabian (Gulf of Oman, Pakistan [type locality: Karachi]).

**Remarks.** The species has erroneously been synonymised with *N. indicus*, a synonym of *N. jousseaumei* (cf. Sakai, 1999; Sepahvand et al., 2018).

### *Neocallichirus mauritanus* (Miers, 1882)

*Callianassa mauritiana* Miers, 1882: 341–342.—Miers, 1884: 15, pl. 1 fig. 2.—Nobili, 1906: 106, figs 5, 6.—Kensley, 1975: 51–53, fig. 3.

*Callianassa (Trypaea) mauritiana*.—Borradaile, 1903: 546 (list).

*Callianassa (Cheramus) mauritiana*.—De Man, 1928a: 26, 99, 160.

*Neocallichirus mauritanus*.—Sakai, 1999: 103, fig. 21.—Sakai, 2011: 461.

**Diagnosis.** Eyestalk distal lobes triangular, rounded, diverging. Major cheliped merus lower margin with distinct proximal prominent square dentate blade, denticulate over distal three-quarters (male), or with proximal prominent triangular dentate blade, denticulate over distal three-quarters (female); gape with deep notch below triangular tooth in male; fixed finger cutting edge smooth; dactylus cutting edge with proximal molar-like tooth, distal half dentate (male). Pereopod 3 propodus with proximally directed lobe of lower margin protruding slightly beyond lower margin of carpus. Uropodal endopod posterior margin decidedly oblique, angle with anterior margin about 40°. Telson clearly tapering from greatest width at midpoint. Maximum cl. 25 mm.

**Distribution.** Western Indian Ocean (known only from type locality: Mauritius).

**Remarks.** The types have been illustrated three times. No material was available for this study. Although the species has been said to occur in the Red Sea (Kensley, 1975; Sakai, 1999) the only hitherto published records are from Mauritius (Miers, 1882; Kensley, 1975). If *Neocallichirus pola* Sakai and Türkay, 2014 were treated as a junior synonym the distribution of *N. mauritiana* would in fact include the Red Sea. The telson in particular of the two species are indistinguishable.

### *Neocallichirus moluccensis* (De Man, 1905)

*Callianassa (Cheramus) moluccensis* (De Man, 1905: 606.—De Man, 1928a: 26, 93, 99, 159–160, pl. 16 fig. 25–25a, pl. 17 fig. 25b–c.

*Neocallichirus moluccensis*.—Kazmi and Kazmi, 1992: 298–299, fig. 2.—Sakai, 1999: 104, fig. 25.—Sakai, 2005: 181–182.—Sakai, 2011: 462.—Sakai and Türkay, 2014: 185, figs 9, 10.

**Diagnosis.** Antenna peduncle exceeding antennule peduncle by one-third of article 5. Eyestalk distal lobes truncate, with distolateral sharp corner. Uropodal endopod posterior margin convex-oblique, angle with anterior margin rounded. Telson clearly tapering from subproximal width to rounded corner between well-defined posterolateral margin and convex-straight posterior margin. Maximum cl. 16.5 mm.

**Distribution.** Eastern Coral Triangle (Indonesia [type locality: Ambon]).

**Remarks.** De Man (1928a), Kazmi and Kazmi (1992) and Sakai (1999) illustrated the holotype of *Neocallichirus moluccensis*, a male (cl. 16.5 mm) without chelipeds from Ambon, Indonesia. These figures are inconsistent, although the cornea appears to be prominent and the anterior lobe on the eyestalk is more or less truncate with a sharp lateral angle. The telson is wider than long, tapering to a narrow posterior margin; the uropodal endopod is about as long as wide and the uropodal exopod about 1.2 times as wide as the anterior margin. A female (cl. 10.3 mm) from Sulawesi is only the second individual illustrated (Sakai and Türkay, 2014), but the eyestalks are rounded, without the anterolateral angle, and the telson more rounded. No material was available for this study.

### *Neocallichirus nagoi* sp. nov.

<https://zoobank.org/urn:lsid:zoobank.org:act:5B5DF4DF-D589-45E6-8042-BAC8949A91F5>

Figures 10, 11

*Neocallichirus* PNG-1589.—Robles et al., 2020: figs 1, 4, 7.

**Material examined.** Holotype. **Papua New Guinea.** New Ireland, Nago I. wharf, 0–1 m, 02° 36.2' S, 150° 46.1' E, 6 Oct 2014 (KAVIENG 2014 stn KM03), MNHN IU-2014-10052 (male, 6.6 mm).

Paratypes, collected with holotype, MNHN IU-2014-10417\* (female, 6.2 mm); MNHN IU-2016-8148\* (male, 7.9 mm); MNHN IU-2016-8149\* (male, 5.5 mm); MNHN IU-2014-10418 (3 males, 5.2–6.0 mm); 3–12 m, sand (KAVIENG 2014 stn KR06), MNHN IU-2014-1157\* (male, 5.8 mm). NMV J62087 (3 males, 5.2–6.0 mm).

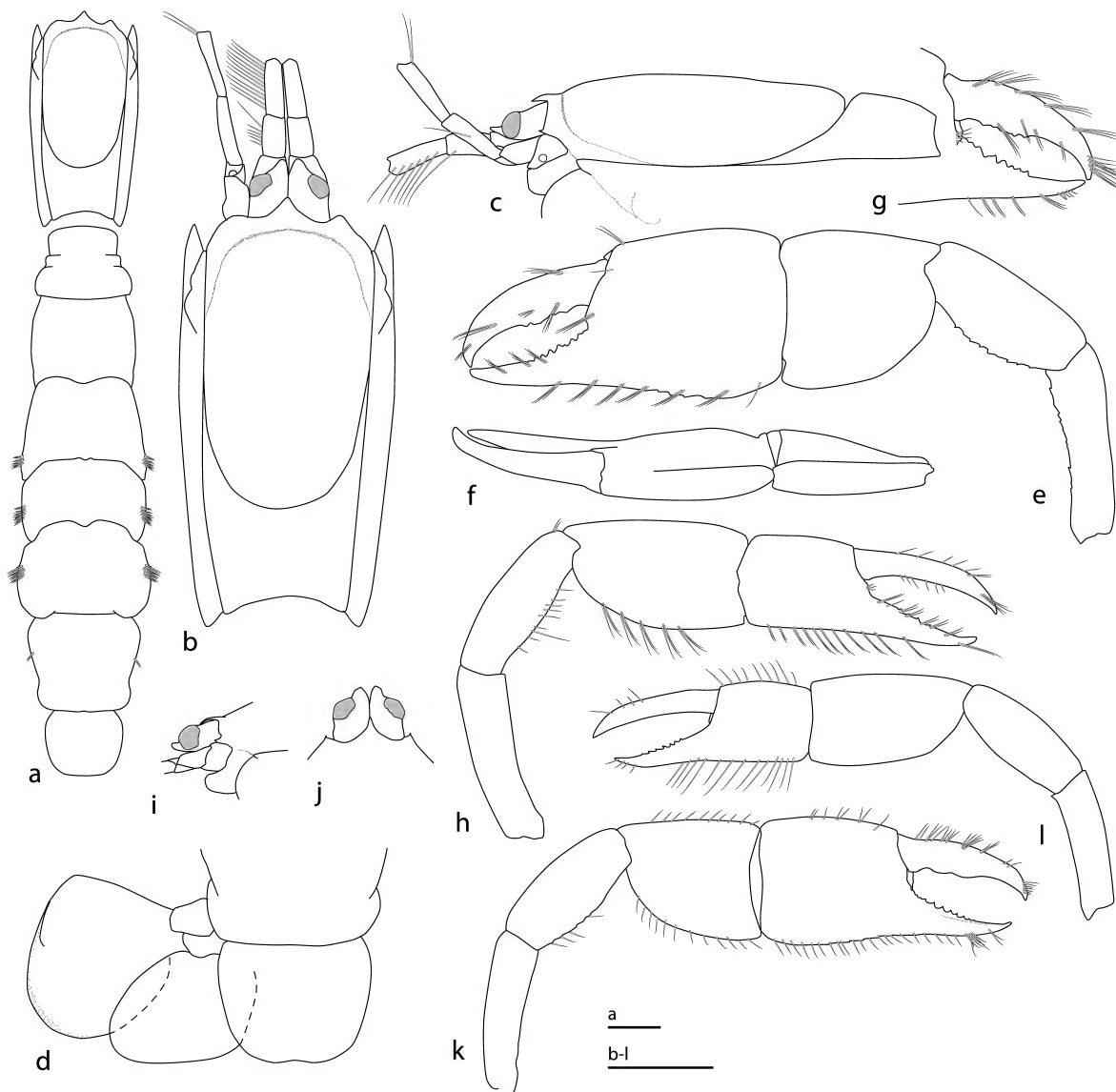


Figure 10. *Neocallichirus nagoi* sp. nov. Papua New Guinea. MNHN IU-2014-10052, holotype male, 6.6 mm: a, carapace, pleon, telson; b, c, carapace, eyestalks, antennular peduncle, antennal peduncle; d, telson, uropod; e, major cheliped (left; lateral); f, major cheliped, carpus–dactylus (upper view); g, major cheliped fingers (mesial); h, minor cheliped (right, lateral). MNHN IU-2014-10417, paratype female, 6.2 mm: i, j, eyestalks; k, major cheliped (left, mesial); l, minor cheliped (right, mesial).

**Diagnosis.** Antenna peduncle exceeding antennule peduncle by half of article 5. Eyestalk distal lobes triangular, rounded, diverging. Major cheliped merus lower margin evenly convex, denticulate; gape simple; fixed finger cutting edge concave, denticulate over proximal half; dactylus cutting edge entire. Uropodal endopod posterior margin convex-oblique, angle with anterior margin rounded. Telson scarcely tapering from subproximal width to broadly rounded posterolateral corner.

**Description.** Carapace c. 0.25 total length; with distinct linea thalassinica, with defined dorsal oval marked posteriorly by deep transverse cervical groove extending anteroventrally to each side above linea thalassinica as shallow groove demarcating posterior half of dorsal oval; frontal margin continued ventrolaterally beyond anterolateral lobe as soft ridge towards linea thalassinica. Branchiostegite with oblique ridge terminating at anterior end of prominent rounded hepatic boss;

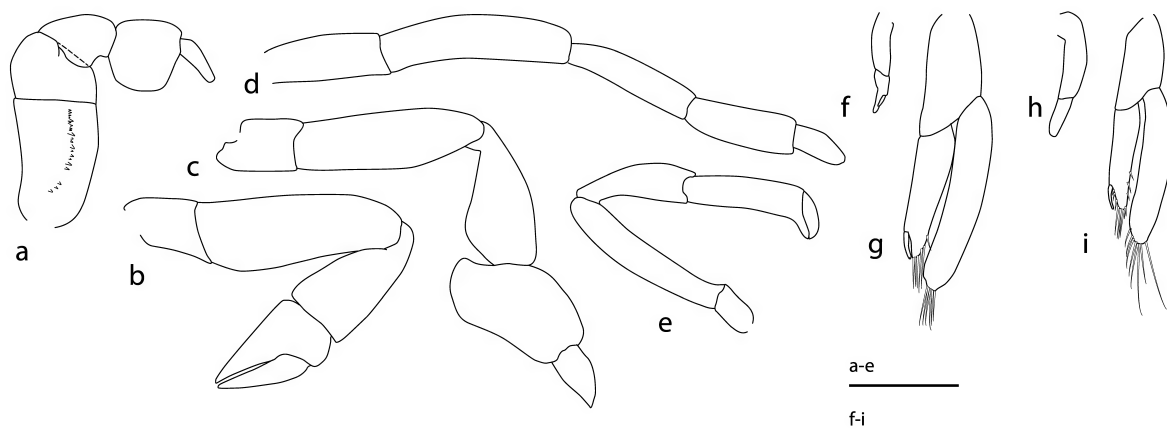


Figure 11. *Neocallichirus nagoi* sp. nov. Papua New Guinea. MNHN IU-2014-10052, holotype male, 6.6 mm: a, maxilliped 3; b–e, pereopods 2–5; f, g, pleopods 1, 2. MNHN IU-2014-10417, paratype female, 6.2 mm: h, i, pleopods 1, 2.

anterior branchiostegal lobe articulating at junction of oblique ridge and linea thalassinica. Rostrum slightly convex in lateral view, broadly triangular, reaching almost to cornea; anterolateral lobe flat, rounded in dorsal view, sometimes with small tubercle. Pleon with approximate ratio of pleonites 1–6 (along midline) 1 : 1 : 1 : 1 : 1.2 : 1.3; pleonites 3–5 with lateral tufts of setae; pleonite 6 with submarginal transverse grooves.

Eyestalk 1.5 times as long as wide, parallel-sided over proximal half, tapering beyond dorsally prominent hemispherical cornea, distal lobes flat, subtriangular, diverging distally, reaching end of antennal article 1. Antennular peduncle 0.4 times carapace length, article 3 1.5 times as long as article 2, with ventromesial and ventrolateral rows of long setae. Antennal peduncle exceeding antennular peduncle by half article 5, articles 4 and 5 subequal in length; scaphocerite semicircular. Maxilliped 3 setation typical of genus; ischium wider distally, extensor margin slightly concave, 1.5 times distal margin, flexor margin convex, crista dentata curved, of c. 22 uneven short sharp spines; merus subtriangular, slightly wider than long, flexor margin broadly rounded; carpus subtriangular, 1.5 times as long as wide, with lobe on flexor margin; propodus slightly wider than long, free distal margin slightly oblique; dactylus slightly arcuate, shorter than propodus.

Pereopods 1 (chelipeds) unequal, dissimilar, scarcely sexually dimorphic, relatively smaller in female. Major cheliped (male) carpus–dactylus 1.2 times carapace length; ischium slender, lower (flexor) margin with denticles over distal half; merus twice as long as wide, upper margin arcuate, lower margin curved, with c. 10 denticles over proximal two-thirds; carpus as long as wide, lower proximal margin regularly curved; propodus upper margin slightly longer than carpus, as long as greatest width, widest subproximally, upper margin carinate over proximal two-thirds, lower margin with submarginal mesial denticles extending on to base of fixed finger; palm distomesial margin with 2 tubercles at base of fixed finger; fixed finger 0.4 length of lower margin, twice as long as width at base, cutting edge with c. 9 triangular blunt

teeth over proximal two-thirds; smooth beyond; dactylus as long as upper margin of palm, cutting edge with irregular blade over proximal half, with acute hooked tip. Minor cheliped (male) barely shorter than major, palm 0.6 width of major palm; ischium narrow, unarmed, as long as merus; merus 3 times as long as wide, margins curved, unarmed; carpus almost as long as merus, 1.7 times as long as wide, widest near midpoint; palm upper margin half as long as carpus, 0.9 times as long as wide, lower margin 1.2 times as long as carpus; fixed finger evenly tapering, half length of lower margin, cutting edge with 5 well spaced denticles over middle third; dactylus 1.6 times as long as upper margin of palm, curved, cutting edge unarmed.

Major cheliped (female) carpus–dactylus 0.8 times carapace length; ischium slender, lower (flexor) margin with minute denticles; merus twice as long as wide, upper margin arcuate, lower margin curved, with c. 10 denticles over proximal two-thirds; carpus 1.2 times as long as wide, lower proximal margin regularly curved; propodus upper margin as long as carpus, little longer than greatest width, widest subproximally, upper margin of palm forming unserrated keel in proximal half, lower margin with submarginal mesial denticles extending on to base of fixed finger; palm distomesial margin unarmed; fixed finger 0.4 length of lower margin, twice as long as width at base, cutting edge with c. 9 triangular blunt teeth over proximal two-thirds, smooth beyond; dactylus as long as upper margin of palm, cutting edge with irregular blade over proximal half, with acute hooked tip. Minor cheliped (female) barely shorter than major, palm 0.6 width of major palm; ischium narrow, unarmed, as long as merus; merus 2.5 times as long as wide, margins curved, unarmed; carpus almost as long as merus, 1.7 times as long as wide, widest near midpoint; palm upper margin half as long as carpus, 1.1 times as long as wide, lower margin 0.8 times as long as carpus; fixed finger evenly tapering, half length of lower margin, cutting edge with 7 well-spaced denticles over middle third; dactylus 1.5 times as long as upper margin of palm, exceeding fixed finger, curved, cutting edge unarmed.

Pereopod 2 merus 3 times as long as wide; carpus 1.8 times as long as wide; chela almost as long as carpus, 1.6 times as long as wide; dactylus 0.7 of chela. Pereopod 3 merus 3 times as long as wide; carpus twice as long as wide; propodus with proximally directed lobe of lower margin aligned with lower margin of carpus, with subsquare proximal angle, with rounded margin leading to straight lower margin, upper margin convex; dactylus teardrop-shaped, 1.8 times as long as wide. Pereopod 4 linear, merus 4.5 times as long as wide; subchela poorly developed. Pereopod 5 fully chelate, fixed finger depressed.

Male pleopod 1 of 2 articles (in juveniles of 1 article or absent); article 2 0.7 time length of article 1, with lateral constriction at about midpoint, with linear appendix interna embedded in distal half of mesial margin, without hooks. Male pleopod 2 peduncle twice as long as wide; endopod slightly shorter than exopod, with subdistal appendix interna reaching end of endopod; without appendix masculina. Female pleopod 1 simple, of 2 articles; article 2 half length of article 1, simple. Female pleopod 2 essentially similar to male. Pleopods 3–5 with short, stubby appendix interna embedded into mesial margin of endopod.

Uropodal endopod as long as wide, anterior margin convex, with rounded corner to distal margin, distal and posterior margins continuous with slightly more exaggerated curvature between, dorsal surface with soft longitudinal carina; exopod 1.5 times as wide as anterior margin, anterior margin almost straight, distal and posterior margins evenly curved, dorsal plate ending submarginally, extending half width of exopod. Telson 1.35 times as wide as long, broadest at lateral lobes in anterior third, tapering at about 10°, posterior margin weakly sinuous, posterolateral corners broadly rounded, each bearing tuft of long setae; dorsal surface elevated anteromedially, with shallow median groove over posterior half.

*Size.* Cl. males 5.2–7.9 mm, female 6.2 mm.

*Etymology.* *Nagoi* is a contraction of Nago Island, the type locality, a noun in apposition.

*Distribution.* Eastern Coral Triangle (known only from type locality, Papua New Guinea).

*Remarks.* All specimens from this collection are similar in size; all except one is a male with open gonopores on the coxae of pereopod 5. The second article of the male pleopod 1 does not have two sharp curved apices typical of the genus, and that of the female is relatively short. These appear immature compared with those of most other species of *Neocallichirus*. The lower margin of the cheliped merus lacks a toothed blade, having instead a row of tubercles, a condition found in *N. darwinensis*, *N. horneri* and *N. moluccensis*. These species differ as follows. *Neocallichirus darwinensis* has reduced cornea, a more tapered telson, narrower minor cheliped and distally excavate propodus on maxilliped 3. *Neocallichirus horneri* has a more tapered telson, a more prominent lobe on the propodus of pereopod 3 and a shorter lower margin on the merus of maxilliped 3. The cornea of *N. moluccensis* is dorsally prominent as in the new species, but the distal eyestalk lobes are more truncate and the telson more tapered.

Robles et al. (2020) found *N. nagoi* (as *N. PNG-1589*) to be sister to a clade containing specimens of *N. calmani* from the

Philippines and French Polynesia, a species from which it differs in many ways.

### *Neocallichirus natalensis* (Barnard, 1947)

*Callianassa natalensis* Barnard, 1947: 379.—Barnard, 1950: 511, fig. 95f–h.—Kensley, 1974: 277.—Sakai, 1999: 100, fig. 23c (cheliped of holotype of *C. natalensis*).

*Neocallichirus natalensis*.—Dworschak, 2011b: 9–10, figs 5, 6I.

*Diagnosis.* Antenna peduncle exceeding antennule peduncle by half of article 5. Cornea prominent, hemispherical (sometimes with extracorneal pigment); eyestalk distal lobes tapered, often truncate, with denticulate distal margin. Major cheliped merus lower margin with deep rectangular denticulate blade over proximal three-quarters, margin straight or gently convex; gape with molar-like tooth in male; fixed finger cutting edge smooth; dactylus cutting edge with molar-like tooth near midpoint, deep notch, concave blade over distal half. Pereopod 3 propodus with proximally directed lobe of lower margin protruding slightly beyond lower margin of carpus. Uropodal endopod posterior margin almost transverse, angle with anterior margin squarish. Telson clearly tapering from subproximal width to rounded corner between well-defined posterolateral margin and convex-straight posterior margin. Maximum cl. 24.4 mm.

*Distribution.* Western Indian Ocean (South Africa [type locality: Natal]; Kenya).

*Remarks.* Sakai (1999) synonymised the species with *N. indicus*, but Dworschak (2011b) resurrected and reillustrated it.

### *Neocallichirus taiaro* Ngoc-Ho, 1995

*Neocallichirus taiaro* Ngoc-Ho 1995: 212–216, figs 1, 2.

*Diagnosis.* Antenna peduncle exceeding antennule peduncle by half of article 5. Eyestalk distal lobes triangular, rounded, diverging. Major cheliped merus lower margin evenly convex, denticulate; gape simple; fixed finger cutting edge smooth; dactylus cutting edge concave, with weak notch one-third way along. Uropodal endopod posterior margin decidedly oblique, curving continuously to convex anterior margin. Telson tapering from base to continuous rounded posterolateral margin. Maximum cl. 4 mm.

*Distribution.* Southeast Polynesia (French Polynesia [type locality: Tuamotu]).

*Remarks.* *Neocallichirus taiaro* Ngoc-Ho, 1995 has been treated as a synonym of *N. indicus* or *N. jousseaumei* (Sakai, 1999; Dworschak, 2011b) but the shape of the eyestalk, chelipeds, female pleopod 2, uropod and telson fall outside the variability of *N. jousseaumei*. None of the specimens of *Neocallichirus* from French Polynesia seen during this study could be identified as *N. taiaro* or *N. jousseaumei*.

### *Neocallichirus vaugelasi* Dworschak, 2011

*Callianassa jousseaumei*.—Dworschak, 1992: 198, figs 5a–d, 6a–c. *Neocallichirus vaugelasi* Dworschak, 2011b: 10–18, figs 7–10.

*Diagnosis.* Antenna peduncle exceeding antennule peduncle by half of article 5. Eyestalk distal lobes elongate, longer than

precorneal length, tapering, diverging, distally transparent. Major cheliped merus lower margin with convex dentate blade except over distal quarter; gape simple; fixed finger cutting edge denticulate over most of length; dactylus cutting edge with molar-like tooth in proximal half, separated by deep notch from broad subtriangular tooth distally. Uropodal endopod posterior margin moderately oblique, angle with anterior margin about 30°. Telson tapering from base to continuous rounded posterolateral margin. Maximum cl. 29.8 mm.

**Distribution.** Red Sea and Gulf of Aden (Jordan [type locality: Aqaba]).

**Remarks.** The species description was based on material reported by de Vaugelas (1984) and has been found only once since (Dworschak, 1992).

### *Neocallichirus vigilax* (De Man, 1916)

*Callianassa* (*Callichirus*) *vigilax* De Man, 1916: 57, pl. 1 figs 1–6.

*Neocallichirus denticulatus* Ngoc-Ho, 1994: 56, fig. 4.

*Neocallichirus vigilax*.—Sakai, 1999: 108.—Sakai, 2011: 464–465.—Dworschak, 2011a: 138–148, figs 1–79 (redescription, complete synonymy).—Dworschak, 2018: 25.—Poore et al., 2019: 141, 145, fig. 15j.—Robles et al., 2020: figs 1, 4, 7.

**Material examined.** *Neocallichirus denticulatus*. **Australia.** Qld, NE of Townsville, 18° 56' S, 146° 50' E, 24 m, NMV J22658 (holotype female, 6.7 mm), MNHN Th1246 (paratype female, 5.5 mm).

*Neocallichirus vigilax*. **Saudi Arabia.** Al Lith, 20.167155° N, 40.223307° E, UF 37165 (female, 12 mm); Farasan Banks, Marca I., 18.22055° N, 41.32438° E, UF 36640 (female, 12 mm); Thuwal, 22.29213° N, 39.09° E, UF 37092 (female, 7 mm). **USA,** Mariana Is, Guam, W coast, near Fish Eye Marine Park, UF 27327 (male); S coast, near Aga Point, UF 29710 (male). **Papua New Guinea.** Madang Province. Riwo, 05° 09' S, 145° 48.2' E, 1–2 m (stn PR235), MNHN IU-2013-7072\* (male, 7.4 mm); MNHN IU-2013-7043 (female, 7.2 mm); (stn PR195), MNHN IU-2013-7105\* (male, 5.2 mm). Madang lagoon, 05° 10.2' S, 145° 50.4' E, 1–3 m (stn PR243), (MNHN IU-2013-7129\* (male, 3.7 mm). New Ireland. NW corner of Little Nusa I., seagrass and sand, 0–1 m, 02° 34.9' S, 150° 46.8' E (stn KM13) MNHN IU-2014-10002\* (female, 12.3 mm); (stn KM11) MNHN IU-2014-2553\* (female, 13.0 mm); MNHN IU-2014-10004 (male, 6.7 mm); MNHN IU-2014-10009 (male, 7.2 mm). **French Polynesia.** Moorea, Haapiti, mangrove area, 17.55668° S, 149.8744° E, UF 15483 (juv., 4 mm), UF 15732 (male, 10.5 mm), Motu Tiahura 17.4891° S, 149.9121° E, UF 16478 (male, 3.3 mm); near Haapiti 17.55475° S, 149.87899° E, UF 29240 (female, 10.9 mm); Papetoai, 17.4911° S, 149.8844° E, UF 16281 (female, 9.5 mm), UF 16284 (female, 11 mm), UF 16293 (male, 5.5 mm), UF 23990 (female, 9.5 mm); between Papetoai and hotel, 17.4908° S, 149.8871° E, UF 16536 (male, 7 mm). **Australia.** Qld, Lizard I., Casuarina Beach, sand flat, 1 m, UF 17515 (male, 8 mm). Qld, Heron I., 23° 27' S, 151° 55' E, reef flat, NMV J40124\* (female); reef flat at Shark Bay, 23.45° S, 151.92° E, NMV J40125 (female, 13 mm, fixed in ethanol). Qld, Rib reef, shallow lagoon, 4 m, 18.47° S, 146.87° E, NMV J74247 (12 specimens), NMV J74248 (5 males and females, 6.8–14.0 mm). Qld, Myrmidon Reef, shallow lagoon, 8 m, 18.27° S, 147.38° E, NMV J74245 (ovigerous female, 12.3 mm), NMV J74246 (12).

**Diagnosis.** Carapace anterolateral lobe acute, prominent. Antenna peduncle exceeding antennule peduncle by half of article 5. Eyestalk distal lobes triangular, rounded, diverging, or truncate, with rounded distal margin, sometimes with dorsal ridge. Major cheliped merus lower margin with narrow straight

dentate blade over proximal three-quarters; palm tuberculate on lateral and distal mesial faces in larger individuals; gape simple; fixed finger cutting edge smooth; dactylus cutting edge obscurely tuberculate, with notch near midpoint. Uropodal endopod posterior margin decidedly oblique, angle with anterior margin about 40°. Telson tapering from base to continuous rounded posterolateral margin. Maximum cl. 24.4 mm.

**Distribution.** Western, Central and Eastern Indo-Pacific (Saudi Arabia, NE Australia, Indonesia [type locality: Ambon], Papua New Guinea, Philippines, Mariana Is, French Polynesia); shallow sand flats.

**Remarks.** The larger specimens agree well with the redescription of this species by Dworschak (2011a). It is notable for the slightly upturned anterolateral carapace spines and the concave anterior margin of the uropodal exopod. In the molecular phylogram based on nuclear and mitochondrial genes (Robles et al., 2020: fig. 4) eight individuals fell into three subclades: two from Madang, Papua New Guinea; two others also from Madang with a third from the Philippines; and two from Nusa I., Papua New Guinea, with a third from Queensland. Clades 2 and 3 are sister clades. No consistent morphological differences could be found between them, supporting the synonymy of *C. denticulatus* with *C. vigilax*.

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## Taxonomic status and distribution of Australian caddisflies (Insecta: Trichoptera)

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### Abstract

Cartwright D., Wells A., Dean J., St Clair R. & Shackleton M. 2023. Taxonomic status and distribution of Australian caddisflies (Insecta: Trichoptera) *Memoirs of Museum Victoria* 82: 97–117.

This review of the status of Australian caddisflies focuses on publications from 1982 to 2022. Information is provided on new species described in that period, new keys, new descriptions of both adults and larvae, and the distribution of families and genera from states/regions and the Northern Territory. Australia's caddisfly fauna now totals 27 families, 111 genera and 868 species, with 97.9% of species endemic to Australia (only 19 of the 868 species are known from outside Australia, mainly from the nearby island of New Guinea – Papua New Guinea and Papua Province, Indonesia); some species also extend into New Zealand and South-East Asia.

The biogeography of the Australian fauna is discussed briefly in terms of “northern” and “southern” faunal elements, faunal provinces, distributional barriers, areas of highest biodiversity and refuge areas. Northern and southern elements in the Australian Trichoptera fauna are indicated. The highest biodiversity is recorded in the following states/regions: New South Wales with 263 species, northern Queensland (N-Qld) with 248 species and Victoria with 247 species. The highest endemism is in southern Western Australia (S-WA), with 73% endemic species, followed by N-Qld with 58% and Tasmania with 57%. The lowest numbers of species have been recorded from South Australia and S-WA, with 42 and 49 species respectively.

### Keywords

Trichoptera, caddisflies, Australia, distribution, biogeography, review

### Introduction

Neboiss (1981) reviewed the caddisfly faunas of the three faunal provinces of Australia (Bassian, Eyrean and Torresian). Over the 40 years since Neboiss' review, there have been many further contributions to the taxonomy of Australian caddisflies. A nomenclatural and taxonomic catalogue (Neboiss, 1988; *Zoological Catalogue of Australia* series) is now updated and available online in the Australian Faunal Directory (ABRS, 2022). Regional compilations are available for Tasmania (Neboiss, 1977, 2003), southern Western Australia (S-WA) (Neboiss, 1982), the Alligator Rivers Region of the Northern Territory (NT) (Wells, 1991 [unpublished]), the Jardine River Region of Cape York Peninsula in north-eastern Queensland (Wells and Cartwright, 1993b), and the Queensland Wet Tropics (QWT) (Walker et al., 1995). These are now out of date, but give introductions to the caddisfly fauna of these areas. Other earlier publications include Neboiss (1983), which records 405 species of Australian caddisfly fauna, representing 24 families, and Walker et al.

(1995, Table 3), which compares the caddisfly fauna of Australia (26 families, 106 genera and 590 species), the QWT (21 families, 67 genera and 217 species, including many undescribed taxa) and the Tasmanian World Heritage Area (TWhA – 19 families, 62 genera and 134 species) and identifies higher species richness in the QWT (about 37% of known Australian fauna) than the TWhA (about 23%). In 1986, Neboiss published the *Atlas of Trichoptera of the SW Pacific–Australian region*, in which all known caddisfly species in Australia (some 439) and the south-west Pacific were figured (Neboiss, 1986b). Since 1982, occasional contributions have added considerably to the Australian fauna, which at the end of 2022 totalled 868 described species in 27 families.

This review aims to provide a useful reference for workers in state and territory agencies, those monitoring stream health, environmental consultants, and students of Trichoptera. It includes the distribution of each family and genus and a bibliography of taxonomic studies since 1982. A summary of the described genera and numbers of species in

each Australian family is shown in Table 1 and is expanded in Supplementary Table 1. Readers are referred to the online Australian Faunal Directory (ABRS, 2022) for taxonomic and nomenclatural information and to the Atlas of Living Australia (2022), which allows access to museum specimen records, particularly those in the large Trichoptera collection of Museums Victoria (accessed from the Online Zoological Collections of Australian Museums – OZCAM).

## Caddisfly taxonomy

### *History of the description of Australian caddisflies.*

Prior to 1900, only ten caddisflies were described from Australia (Neboiss, 1988). Another four species, subsequently listed for Australia, were described from non-Australian locations prior to 1900 and recorded in Australia subsequently: *Philanisus plebeius* Walker (1852; described from New Zealand), *Aethaloptera sexpunctata* (Kolenati) (1859; described from India), *Macrostemum saundersii* (McLachlan) (1866; described from Irian Jaya) and *Oecetis hemerobioides* (McLachlan) (1866; described from Sulawesi [as Celebes]). Neboiss, in his 1988 catalogue, listed the trickle of descriptions of new species published in the years from 1900 to 1940 by Ulmer, Martynov, Banks, Navás, Mosely and Tillyard; Tillyard (1922) listed a total of 49 species. In 1953, Mosely and Kimmins published a comprehensive study of 177 species. Many of these were newly described, and the authors provided a brief analysis of the distributions of Australian caddisflies.

Several smaller additions followed Mosely and Kimmins' work: Ross (1956), Neboiss (1962, 1974, 1975), Korboot (1964b), Jacquemart (1965), Schmid (1969) and Riek (1977). In 1977, Neboiss published his major study of Tasmanian caddisflies, listing 21 families with about 160 species, of which around 74% were endemic to Tasmania. Further, in 1982, Neboiss recorded for S-WA some nine families and 43 species, about 70% of which were listed as endemic. In a checklist published in 1983, Neboiss listed 24 families and 405 species, and later an atlas (Neboiss, 1986b) that included 436 figured species.

### *Descriptions of adult Trichoptera since 1982.*

Since 1982, many new taxa in assorted families have been described, including Antipodoeciidae (St Clair et al., 2018), Calocidae (Neboiss, 1984a; Shackleton, 2010, 2013; Shackleton and Webb, 2014a, 2015; Shackleton et al., 2014b), Hydrobiosidae (Schmid, 1989), Hydropsychidae (Neboiss, 1984c; Dean, 2001; Wells and Neboiss, 2018), Hydroptilidae (Wells, 1985a, 1990, 1998, 1999, 2002, 2005, 2010b, 2021; Wells and Dostine, 2016; Wells and Kjer, 2016), Leptoceridae (St Clair, 1988; Neboiss, 1989; Neboiss and Wells, 1998; Wells, 2000, 2004, 2006), Ecnomidae (Cartwright, 1990b, 2008, 2009, 2010a, 2011a), Odontoceridae (Wells and St Clair, 2021), Polycentropodidae (Neboiss, 1992b, 1994; Cartwright, 2021), Helicopsychidae (Johanson, 1995, 1997), Conoesucidae (Jackson, 1998b), Atriplectidae (Neboiss, 1999), Philopotamidae (Cartwright, 2002, 2010b, 2012a, 2012b, 2012c), Glossosomatidae (Wells, 2010a), Tasmanian species (Neboiss, 2003) and other small papers (Neboiss, 1984b,

1986a; Cartwright, 2011b; Wickson et al., 2014; Wells, 2020; Cartwright and Dostine, 2022).

We currently recognise a total of 27 Trichoptera families, 111 genera and 868 species from Australia. Fig. 1 illustrates the rapid increase in description of Australian species in recent years. This increase, along with the knowledge that many undescribed species exist in collections, suggests that the total Australian Trichoptera fauna will certainly exceed 900 and possibly 1000 species. Many descriptions of new species from several families are currently being prepared.

### *Larval keys and descriptions since 1982.*

Keys to larvae are available for Victorian free-living families and genera (Dean and Cartwright, 1982); for Australian voucher species in the families Ecnomidae, Philopotamidae and Tasimiidae (Cartwright, 1997); Hydroptilidae Wells (1997); Philorheithridae, Calamoceratidae and Helicopsychidae (St Clair, 1997); Polycentropodidae, Glossosomatidae, Dipsudopsidae and Psychomyiidae (Cartwright, 1998); Calocidae, Helicophidae and Conoesucidae (Jackson, 1998a); Hydropsychidae (Dean, 1999); Antipodoeciidae, Atriplectidae, Limnephilidae and Plectrotarsidae (Dean, 2000); Leptoceridae (St Clair, 2000a); Odontoceridae, Kokiriidae and Oeconesidae (St Clair, 2000b); and for all Australian genera (Dean, St Clair, and Cartwright, 2004). The major keys published for the series of workshops run by the Murray–Darling Freshwater Research Centre are now available online in *The bug guide* (Hawking et al., 2009) and the *Interactive guide to Australian aquatic invertebrates* (Gunn et al., 1999) is available online through LucidCentral (<https://www.lucidcentral.org>). Detailed larval descriptions are comparatively few, and are listed in Table 2.

### *Summary of major taxonomic changes since 1982.*

Neboiss (1983) documented the status of Australian adult Trichoptera taxonomy up to the end of 1982. His work included a checklist of species, with areas of distribution, and data on type specimens and depository institutions. In 1986, Neboiss published the *Atlas of Trichoptera* of the SW Pacific–Australian region, in which figures were provided for all known Australian species.

Family level – number of families has increased from 24 to 27 since 1982.

Psychomyiidae – first recorded from Australia by Mosely and Kimmins (1953), removed from the Australian fauna by Neboiss (1977), but then re-established by Neboiss (1990) with the recognition of two genera, *Tinodes* and *Zealandoptila*.

Dipseudopsidae – *Hyalopsyche* first recorded from Australia and placed in the family Polycentropodidae by Neboiss (1980), moved to the family Hyalopsychidae by Schmid (1980), subsequently transferred from Hyalopsychidae to Dipseudopsidae (Wells and Cartwright, 1993a).

Helocobucidae – *Helocobus buccinatus* Neboiss, 2002, originally placed in Helicophidae, family erected by Johanson et al. (2017).

Generic level – number of genera increased from 96 to 111 since 1982.

Table 1. A summary of families, numbers of described genera and species in Australian state/territory/region (0/L = larval record only) as at December 2012.

Family	#Genera/ species		S-WA	N-WA	NT	N-Qld	S-Qld	NSW	Vic	Tas	SA
Glossosomatidae	1	23	0	0	0	4	0	11	9	3	0
Hydrobiosidae	15	67	2	0	0	3	8	27	29	33	2
Hydroptilidae	15	162	8	27	44	58	20	38	41	22	12
Philopotamidae	2	82	2	10	7	17	12	20	17	16	0
Stenopsychidae	1	9	0	0	0	2	0	6	3	1	0
Dipseudopsidae	1	1	0	0	1	1	0	0	0	0	0
Ecnomidae	7	126	9	31	34	38	27	33	33	10	7
Hydropsychidae	9	55	2	4	5	20	16	16	12	10	1
Polycentropodidae	5	21	2	2	6	7	0	3	3	7	0
Psychomyiidae	2	3	0	0	1	3	0	0	0	0	0
Limnephilidae	1	2	0	0	0	0	0	1	2	1	0
Oeconesidae	1	1	0	0	0	0	0	0	0	1	0
Plectrotarsidae	3	5	1	0	0	0	0	1	1	4	0
Atriplectididae	1	2	1	0	0	2	0	1	1	1	1
Calamoceratidae	1	10	0	2	2	5	2	3	3	1	1
Kokiriidae	3	5	0	0	0	0	0	0	2	3	0
Leptoceridae	15	180	21	42	51	72	37	49	53	35	16
Odontoceridae	2	11	0	0	0	2	3	7	1	1	0
Philorheithridae	5	15	1	0	0	0	0	5	7	11	0
Antipodoeciidae	1	1	0	0	0	0	0	1	0	0	0
Calocidae	6	32	0	0	0	7	3	13	11	5	0
Chathamidae	1	2	0	0	0	0	0	2	1	0	0
Conoesucidae	6	23	0	0	0	0	0	7	6	19	1
Helicophidae	2	7	0	0	0	0	1	4	1	5	0
Helocobucidae	1	1	0	0	0	0	1	1	1	0	0
Helicopsychidae	1	15	0	2	2	6	5	7	5	2	0
Tasimiidae	2	7	0	0	0	1	2	6	5	4	1
<b>Total in all families</b>	<b>111</b>	<b>868</b>	<b>49</b>	<b>118</b>	<b>153</b>	<b>248</b>	<b>138</b>	<b>263</b>	<b>247</b>	<b>195</b>	<b>42</b>
% of total Aust. species		6	14	18	29	16	30	29	23	5	
% of species endemic		73.5	21	25	58	25	31	30	57	7	

A more complete family, genus and species number checklist with associated state/territory/region distribution is attached in the Appendix 1 (or Supplementary file). A complete species checklist is not included here because it would duplicate information available on several websites: internet checklists in various forms are incorporated in the Trichoptera World Checklist (Morse, J.C. (ed.) 2022. <http://entweb.clemson.edu/database/trichopt/index.htm> (accessed 25 November 2022) and the Australian Faunal Directory ([www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/Trichoptera/checklist](http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/taxa/Trichoptera/checklist)). They do have limitations with respect to regional or state species numbers, but have the advantage of being constantly upgraded. A table with a complete list of Australian species shown in each state/territory/region is available in the Appendix.

Table 2. List of described Trichoptera larvae from Australia, with references.

Family	Name	Reference	Notes
Antipodociidae	<i>Antipodoecia turneri</i> Mosely, 1934	St Clair et al., 2018	Not certain this particular species is described.
Atriplectididae	<i>Atriplectides dubius</i> Neboiss, 1978	Neboiss, 1978	
	<i>Atriplectides ikmaleus</i> Neboiss, 1999	Neboiss, 1999	
Calocidae	<i>Coenota cudonis</i> Shackleton and Webb, 2015	Shackleton and Webb, 2015	
	<i>Coenota equustagna</i> Shackleton and Webb, 2015	Shackleton and Webb, 2015	
	<i>Coenota nemerosa</i> Shackleton and Webb, 2015	Shackleton and Webb, 2015	
	<i>Caloca saneva</i> Neboiss, 1979	Neboiss, 1979	
	<i>Calocoides pravuspina</i> , Shackleton and Webb 2014	Shackleton and Webb, 2014	
	<i>Calocoides mynottae</i> Shackleton and Webb, 2014	Shackleton and Webb, 2014	
	<i>Latarima explicatala</i> Shackleton, Webb, Lawler and Suter, 2014	Shackleton et al., 2014	
	<i>Pliocaloca fidesria</i> Shackleton, 2010	Shackleton, 2010	
	<i>Pliocaloca kleithria</i> Shackleton, 2010	Shackleton, 2010	
Chathamidae	<i>Philanitus plebius</i> Riek, 1977	Riek, 1977	
Conoesucidae	<i>Conoesucus adiaxolus</i> Jackson 1998	Jackson, 1998b	
	<i>Conoesucus notialis</i> Jackson, 1998	Jackson, 1998b	
Dipseudopsidae	<i>Hyalopsyche disjuncta</i> Neboiss 1980	Wells and Cartwright, 1993	
Helicophidae	<i>Allocoella grisea</i> Banks 1939	Drechtrah 1984	
Helicopsychidae	<i>Helicopsyche cochleata</i> Korboot, 1964	Korboot, 1964a	
Helocabusidae	<i>Helocabus buccanatus</i> Neboiss, 2002	Neboiss, 2002	
Hydrobiosidae	<i>Apsilochorema urdalum</i> Neboiss, 1962	Dean and Bunn, 1989	
	<i>Taschorema pallescens</i> (Banks, 1939)	Dean and Bunn, 1989	
Hydropsychidae	<i>Baliomorpha pulchripenne</i> Tillyard, 1922	Dean, 1984	
	<i>Cheumatopsyche dostinei</i> Dean, 2001	Dean, 2001	
	<i>Cheumatopsyche kakaduensis</i> Dean, 2001	Dean, 2001	
	<i>Cheumatopsyche suteri</i> Dean, 2001	Dean, 2001	
	<i>Cheumatopsyche wellsae</i> Dean, 2001	Dean, 2001	
	<i>Smicrophylax australis</i> Tillyard, 1989	Dean and Bunn, 1989	
Hydroptilidae	<i>Acrptoptila globosa</i> Wells, 1982	Wells, 1985b	
	<i>Hellyethira basilobata</i> Wells, 1979	Wells, 1985b	
	<i>Hellyethira cornuta</i> Wells, 1979	Wells, 1985b	
	<i>Hellyethira eskensis</i> (Mosely, 1934)	Wells, 1985b	
	<i>Hellyethira exserta</i> Wells, 1979	Wells, 1985b	
	<i>Hellyethira litua</i> Wells, 1979	Wells, 1985b	
	<i>Hellyethira malleoforma</i> Wells, 1979	Wells, 1985b	
	<i>Hellyethira ramosa</i> Wells, 1983	Wells, 1985b	
	<i>Hellyethira simplex</i> (Mosely, 1934)	Wells, 1985b	
	<i>Hellyethira vernoni</i> Wells, 1983	Wells, 1985b	
	<i>Hydroptila acinacis</i> Wells, 1979	Wells, 1985b	

Family	Name	Reference	Notes
	<i>Hydroptila losida</i> Mosely, 1953	Wells, 1985b	
	<i>Hydroptila scamandra</i> Neboiss, 1977	Wells, 1985b	
	<i>Maydenoptila baynesi</i> Wells, 1983	Wells, 1985b	
	<i>Maydenoptila rupina</i> Neboiss, 1977	Wells, 1985b	
	<i>Orphninostrichia maculata</i> Mosely, 1934	Wells, 1985b	
	<i>Orthotrichia bishopi</i> Wells, 1979	Wells, 1985b	
	<i>Oxyethira columba</i> (Neboiss, 1977)	Wells, 1985b	
	<i>Tricholeiochiton fidelis</i> Wells, 1982	Wells, 1985b	
Kokiriidae	<i>Tanjistomella verna</i> Neboiss, 1974	Neboiss, 1974	
Leptoceridae	<i>Hudsonema aptus</i> (Neboiss, 1982)	St Clair, 2002	
	<i>Hudsonema paludosus</i> (Neboiss, 1977)	St Clair, 1994	
	<i>Lectrides varians</i> Mosely, 1953	Jackson, 1985	
	<i>Leptocerus souta</i> Schmid, 1988	St Clair, 1994	
	<i>Leptorussa darlingtoni</i> (Banks, 1939)	Jackson, 1985	
	<i>Notalina arena</i> St Clair, 1991	St Clair, 1991	
	<i>Notalina bifaria</i> Neboiss, 1977	St Clair, 1991	
	<i>Notalina fulva</i> Kimmins, 1953	St Clair, 1991	
	<i>Notalina ordina</i> St Clair, 1991	St Clair, 1991	
	<i>Notalina salina</i> St Clair, 1991	St Clair, 1991	
	<i>Notalina spira</i> St Clair, 1991	St Clair, 1991	
	<i>Notoperata maculata</i> (Mosely, 1953)	St Clair, 1994	
	<i>Notoperata sparsa</i> (Kimmins, 1953)	St Clair, 1994	
	<i>Notoperata tenax</i> Neboiss, 1982	St Clair, 2002	
	<i>Oecetis australis</i> (Banks, 1920)	Korboot, 1964a	Larvae described as <i>O. situlus</i> but is <i>Notalina fulva</i>
	<i>Oecetis laustra</i> Mosely, 1953	St Clair, 1994	Description no longer adequate for species recognition.
	<i>Russobex cuneatus</i> St Clair, 1988	St Clair, 1988	
	<i>Symphitonueria neboissi</i> , Wells, 2011	Wells, 2011	Detailed notes given in Wells, 2011
	<i>Symphitonueria opposita</i> (Walker, 1852)	St Clair, 2002	
	<i>Symphitoneuria wheeleri</i> Banks, 1939	St Clair, 1994	
	<i>Triaenodes volda</i> Mosely, 1953	St Clair, 1994	Description no longer adequate for species recognition.
	<i>Triplectides altenogus</i> Morse & Neboiss, 1982	St Clair, 1994	
	<i>Triplectides australicus</i> Banks, 1939	St Clair, 1994	
	<i>Triplectides australis</i> Navas, 1934	St Clair, 1994	
	<i>Triplectides ciuskus ciuskus</i> Mosely, 1953	St Clair, 1994	
	<i>Triplectides elongatus</i> Banks, 1939	St Clair, 1994	
	<i>Triplectides enthesi</i> Morse & Neboiss, 1982	St Clair, 2002	
	<i>Triplectides magnus</i> (Walker, 1852)	St Clair, 1994	
	<i>Triplectides niveipennis</i> Mosely, 1953	St Clair, 2002	
	<i>Triplectides proximus</i> Neboiss, 1977	St Clair, 1994	



Family	Name	Reference	Notes
	<i>Triplectides truncatus</i> Neboiss, 1977	St Clair, 1994	
	<i>Triplectides similis</i> Mosely, 1953	St Clair, 1994	
	<i>Triplectides voldi</i> Mosely, 1953	St Clair, 1994	
	<i>Triplectides varius</i> Kimmins, 1953	St Clair, 1994	
	<i>Triplectidina nigricornis</i> Mosely, 1936	St Clair, 1994	
	<i>Triplexa villa</i> Mosely, 1953	St Clair, 1994	
	<i>Westriplectides pedderensis</i> Neboiss, 1977	St Clair, 1994	
Limnephilidae	<i>Archaeophylax ochreus</i> Mosely, 1953	Neboiss, 1958	
Odontoceridae	<i>Marilia disjuncta</i> Wells and St Clair, 2021	Drecktrah, 1990	As <i>M. fusca</i> , now <i>Marilia</i> larval sp. 2 in Wells and St Clair, 2018.
	<i>Barynema costatum</i> Banks, 1939	Cartwright and Dean, 1987	Possibly the larva of <i>B. paradoxa</i> , Wells and St Clair, 2018.
Oeconesidae	<i>Tascuna ignota</i> Neboiss, 1975		Larva discussed and figured in Neboiss, 1987.
Philopotamidae	<i>Chimarra australica</i> (Ulmer, 1916)	Cartwright, 1990a	
	<i>Chimarra monticola</i> Kimmins, 1953	Cartwright, 1990a	
	<i>Hydrobiosella letti</i> Korboot, 1964	Korboot, 1964a	Larva illustrated is a species of <i>Chimarra</i>
Plectrotarsidae	<i>Plectrotarsus gravenhorsti</i> Kolenati, 1848	Neboiss, 1987	
Polycentropodidae	<i>Neureclipsis napaea</i> Neboiss, 1986	Cartwright, 1991	
Psychomyiidae	<i>Tinodes radona</i> Neboiss, 1990	Wells, 1995	
Tasimiidae	<i>Tasiagma eremica</i> Wells, 2011	Wells, 2011	Figured in Wells, 2011
	<i>Tasimia natasia</i> Mosely, 1953	Riek, 1968	

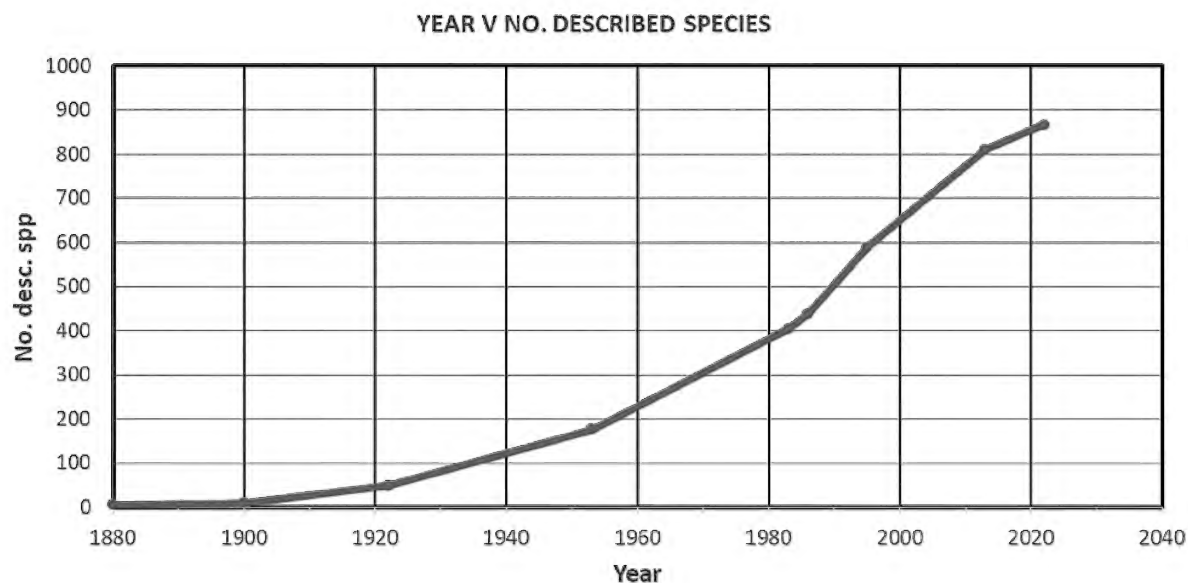


Figure 1. Cumulative number of described species of Australian caddisflies, 1880–2022.

Helicopsychidae – the genus *Saetotricha* was removed from the Australian fauna when *S. ptychopteryx* was transferred to *Helicopsyche* (Neboiss, 1986c).

Hydrobiosidae – a new genus *Poecilochorema* was created with the transfer of four species (*P. complexa*, *P. crinitum*, *P. evansi* and *P. lepnevae*) from *Austrochorema* and the description of one new species, *P. circumvoltum* Schmid (Schmid, 1989).

Hydroptilidae – *Gnathotrichia* and *Stenoxyethira* were synonymised with *Oxyethira* (Kelley, 1984); one species of each of the SE Asian genera *Chrysotrichia* Schmid 1989 (Wells, 1990) and *Scelotrichia* Ulmer, 1951 (Cairns and Wells, 2008) (name now replaced by *Pseudoxxyethira* Schmid, 1958) were new genus records for Australia, and a new genus, *Jabitrachia* Wells, 1990 was erected for a single species (the genus has since been recorded from W Malaysia and E Africa).

Hydropsychidae – the genus *Macronema* was removed from Australia when three species (*M. banksi*, *M. dubia* and *M. pulchripenne*) were transferred to a new genus *Baliomorpha* (Neboiss, 1984c); *Macrostemum* added (Neboiss, 1984c); the generic name *Sciops* was removed from the Australian fauna with the transfer of two species (*S. spinata* Banks and *S. inermis* Banks) to *Dipletrona* (Neboiss, 1986a); the new genus *Diemeniluma* Neboiss, 2003 was described to accommodate two Tasmanian species, one new and the other having previously been placed in the genus *Dipletrona*. *Diemeniluma* was synonymised subsequently with *Dipletrona* by Wells and Neboiss (2018), who also established a new genus, *Arcyphysa* Wells and Neboiss.

Polycentropodidae – the genus *Neureclipsis* was newly recorded from Australia (Neboiss, 1986a), *Nyctiophylax* species were moved to *Paranyctiophylax* (Neboiss, 1992b, 1994), and back to *Nyctiophylax* (Malicky, 1994); *Tasmanoplegus* was synonymised with *Plectrocnemia* (Oláh and Johanson, 2010).

Calocidae – genera *Calocoides* and *Pliocaloca* described from Queensland (Neboiss, 1984b), *Latarima* described from Victoria (Shackleton et al., 2014).

Leptoceridae – a new monotypic genus *Russobex* St Clair, 1988 described from Victoria; *Condoceris* removed to *Hudsonema* (Malm and Johanson, 2011) based on DNA and adult morphology, but none of the available information on larvae was included in the analysis.

Helicophidae – a new monotypic genus *Heloccabus* Neboiss, 2002 from eastern Australia, provisionally placed in this family; subsequently moved to new family (Heloccobucidae) by Neboiss (2002).

Ecnomidae – *Ecnomina* split into two: *Ecnomina* s. str. and *Daternomina* by Neboiss (2003) in revision of Tasmanian adults. South and central American genus *Austrotinodes* recorded from Australia (Cartwright, 2009); three additional genera established by Cartwright in 2010 (*Absensomina* and *Wellsomina*) and in 2011 (*Neboisomina*).

Species level – the number of species increased from 405 (Neboiss, 1983) to 868 in 2022.

### Australia – biogeography

Neboiss (1981) reviewed the characterisation of Australia's faunal provinces, refuge areas and distributional barriers. A map of Australia (based on Neboiss, 1981) showing states, regions, faunal barriers and drainage basins and their total caddisfly fauna and percentage endemism was included in Neboiss (1988, Zoological Catalogue, Map 1), and is shown in Fig. 2.

### Summary of the Australian Trichoptera fauna.

The known Australia Trichoptera fauna consists of 27 families, 111 genera and 868 species (Table 2). Table 3 shows that Australia has approximately 57% of the world's described families, 18% of the world's described genera and 6% of the world's described species (Morse, 2022).

Australia's caddisfly fauna is dominated by the families Leptoceridae, Hydroptilidae, Ecnomidae, Philopotamidae, Hydrobiosidae and Hydropsychidae, with a combined total of 672 species or approximately 77% of the known Australian fauna. The top six dominant or most speciose families are shown in Table 4. Unsurprisingly, Australia's eight most

Table 3. Caddisfly fauna richness in Australia and other regions of the world (Morse, 2022). NB. Some regional figures are approximate, because some newly described species have not been updated on the World Checklist (Morse, pers. comm.)

Biogeographical region	Families	No of species 2022	% of world species 2022
Australia	27	868	4.9
Australasian	29	1880	10.7
Neotropical	23	3350	19.1
Nearctic	27	1700	9.7
East Palearctic	29	1300	7.5
West Palearctic	26	2160	12.3
Afrotropical	23	1250	7.1
Oriental	28	5890	33.6
<b>World</b>	<b>47</b>	<b>17530</b>	<b>100</b>

Table 4. Australia's most speciose families with percentage of total Australian Trichoptera fauna.

Family	No. of genera	No of species	% of fauna
Leptoceridae	15	180	20.7
Hydroptilidae	15	162	18.7
Ecnomidae	7	126	14.5
Philopotamidae	2	82	9.4
Hydrobiosidae	15	67	7.7
Hydropsychidae	9	55	6.3
<b>Total (% of Aust. total)</b>	<b>63 (57%)</b>	<b>672 (77%)</b>	<b>77.3%</b>

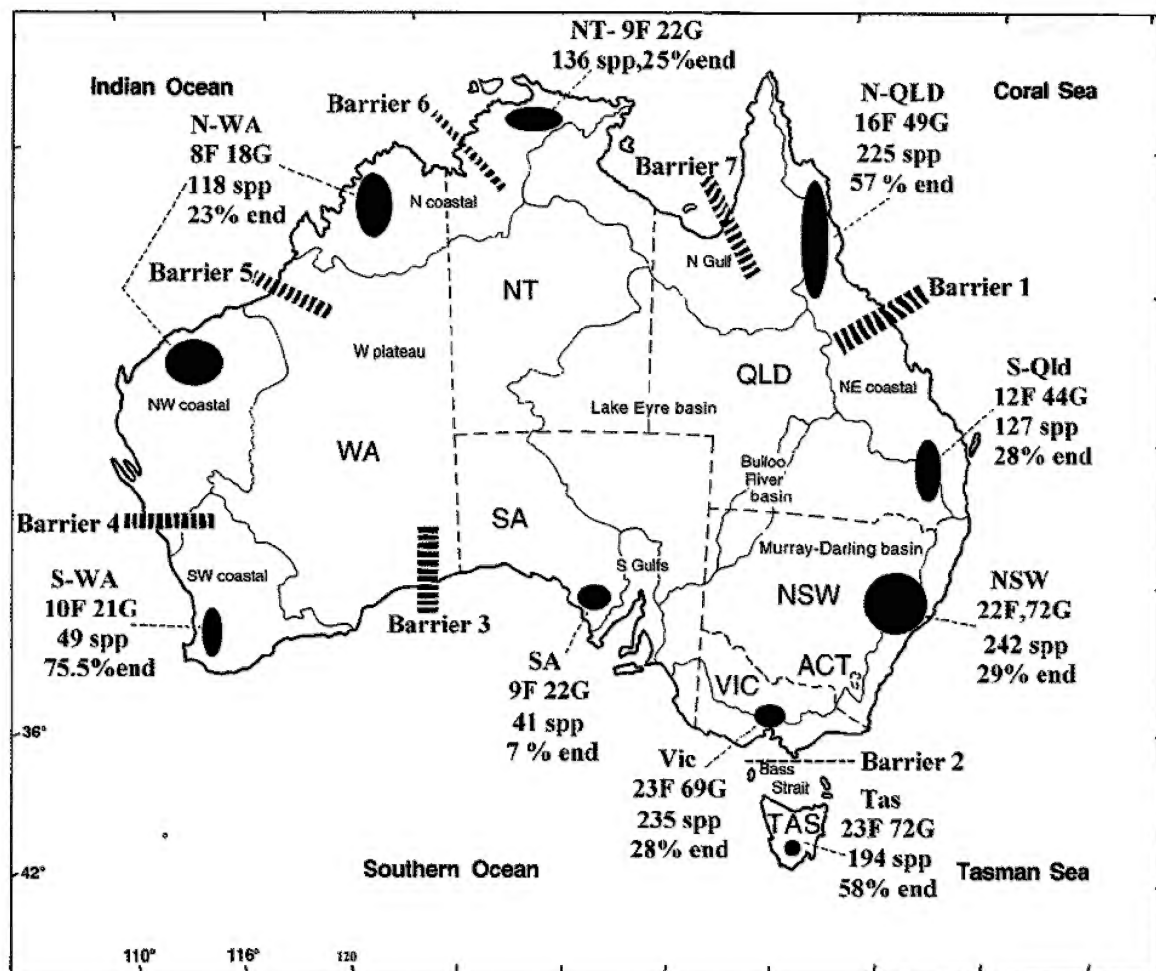


Figure 2. Map of Australia showing breakdown of states and regions (= major drainage basins) as adopted for the Zoological Catalogue of Australia series (e.g., Walton and Houston, 1988, Map 1). Map abbreviations: N-Qld = northern Queensland, S-Qld = southern Queensland, NSW = New South Wales (incorporating ACT = Australian Capital Territory), Vic = Victoria, Tas = Tasmania, SA = South Australia, S-WA = southern Western Australia, N-WA = northern Western Australia (incorporating Pilbara and Kimberley Regions), NT = Northern Territory. For convenience, the larger states, WA and Qld, are divided into two areas: north (N) and south (S). Barriers 1–7 are detailed below. We have divided Western Australia at Barrier 4 (between Geraldton and Pilbara region) and Queensland at Barrier 1 (area between Townsville and Rockhampton); F = family, G = genus, spp = species, end = endemism.

speciose genera (shown in Table 5) are also in the families Leptoceridae (*Oecetis* with 67 and *Triaenodes* with 48 species), Philopotamidae (*Hydrobiosella* with 54 and *Chimarra* with 28 species), Hydroptilidae (*Orthotrichia* with 55 and *Hellyethira* with 30 species) and Ecnomidae (*Ecnomus* with 40 and *Ecnomina* with 37 species).

*Major patterns in the Australian Trichoptera fauna.* Generally, the Australian fauna can be divided primarily into northern and southern elements (even within the same family) (for examples, see Figs 3a and b).

*Northern Australian Trichoptera fauna (N-WA, NT, N-Qld) (= Torresian Province).* Northern or Torresian Australia includes three sub-regions – N-WA (Kimberley and Pilbara Regions), NT and N-Qld – and is dominated numerically by species of the Leptoceridae (*Oecetis* and *Triaenodes*), Ecnomidae (*Ecnomus* and *Wellsomina*), Hydroptilidae (*Orthotrichia* and *Hellyethira*), and Philopotamidae (*Chimarra*) (see Table 6). Twenty families are represented in northern Australia (however, only ten northern families are found outside the QWT). *Wellsomina* is an endemic northern genus; examples of predominantly northern genera are *Tricholeiochiton*, *Hellyethira*, *Chimarra* and *Oecetis*. Some of these genera, for example, *Oecetis* and *Triaenodes*, have possibly moved to Australia comparatively recently from the north after the Australian plate moved close to New Guinea.

N-WA faunal elements include nine families, 20 genera and 118 species, with 21% of species endemic. The most speciose three families, Leptoceridae (42), Ecnomidae (31) and Hydroptilidae (27), with a combined 100 species, comprise 85% of the total.

NT faunal elements include ten families, 24 genera and 153 species, with 24% of species endemic. The most speciose three families, Leptoceridae (51), Hydroptilidae (44) and

Ecnomidae (34), with a combined 129 species, comprise 84% of the total.

N-Qld faunal elements include 17 families, 55 genera and 248 species, with 58% of species endemic. The most speciose three families, Leptoceridae (72), Hydroptilidae (58) and Ecnomidae (38), with a combined 168 species, comprise 68% of the total.

*Southern Australian Trichoptera fauna (S-Qld, New South Wales [NSW], Victoria, Tasmania, South Australia [SA], S-WA) (= Bassian Province).* Neboiss (1981) reviewed the caddisfly fauna of the three sub-regions of southern or Bassian Australia: SE mainland, with 23 families and an estimated 200 species (Neboiss, 1981); Tasmanian – 23 families, about 160 species, 74% endemic (Neboiss, 1977); and SW Australia – nine families, 43 species, about 70% endemic; dominant families Leptoceridae, with 18 species in nine genera, and Ecnomidae, with three genera and nine species (Neboiss, 1982).

Our current assessment is that southern or Bassian Australia is dominated numerically by species in mostly the same families as those that dominate northern Australia, although we find that, generally, different genera are predominant: Leptoceridae (*Triplectides* and *Notalina*), Philopotamidae (*Hydrobiosella*), Ecnomidae (*Ecnomina*), Glossosomatidae (*Agapetus*) and Hydroptilidae (*Orphninostrichia*) (see Table 7). Other predominantly southern families include the Hydrobiosidae, Philorheithridae, Conoesucidae, Calocidae, Helicophidae, Tasiimidae and Plectrotarsidae. Many of the 'southern families and genera (e.g., Philorheithridae, Helicophidae, *Triplectides* and *Notalina*) are of Gondwanan origin and probably have been in Australia for far longer than the northern families and genera.

Twenty-four Trichoptera families are represented in southern Australia.

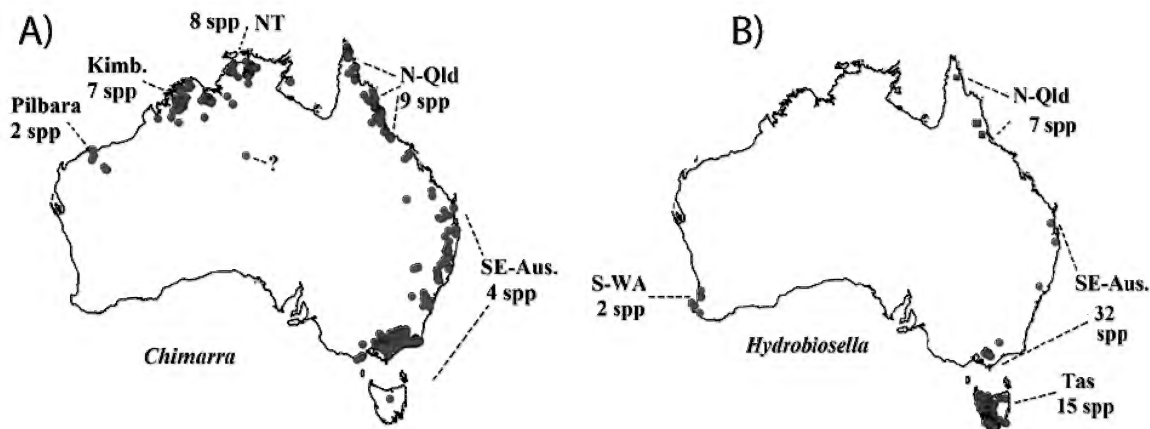


Figure 3. Australian maps showing records (in blue) of A) a mostly 'northern' genus *Chimarra* (with 79% species northern) and B) a mostly 'southern' genus *Hydrobiosella* (with 89% species southern) (after Atlas of Living Australia (accessed 2012))

Table 5. Australia's most speciose Trichoptera genera.

Genus	Family	No. of species
<i>Oecetis</i>	Leptoceridae	67
<i>Orthotrichia</i>	Hydroptilidae	55
<i>Hydrobiosella</i>	Philopotamidae	54
<i>Triaenodes</i>	Leptoceridae	48
<i>Ecnomus</i>	Ecnomidae	40
<i>Ecnomina</i>	Ecnomidae	37
<i>Hellyethira</i>	Hydroptilidae	30
<i>Chimarra</i>	Philopotamidae	28

Table 6. Major families, genera, and number and percentage of species of Trichoptera represented in 'northern' or Torresian Australia.

Family	Genus	N-WA	NT	N-Qld	Total spp in genus 'northern'	% spp in genus 'northern'
Leptoceridae	<i>Oecetis</i>	26	32	35	40	60
Hydroptilidae	<i>Orthotrichia</i>	12	21	24	36	65
Leptoceridae	<i>Triaenodes</i>	11	13	18	31	65
Ecnomidae	<i>Ecnomus</i>	20	23	16	25	63
Philopotamidae	<i>Chimarra</i>	10	7	10	22	79
Hydroptilidae	<i>Hellyethira</i>	9	10	13	21	70
Ecnomidae	<i>Wellsomina</i>	8	7	2	13	100

Table 7. Major families, genera and number and percentage of Trichoptera represented in 'southern' or Bassian Australia.

Family	Genus	S-WA	SA	Tas	Vic	NSW	S-Qld	Total spp in genus 'southern'	% spp in genus 'southern'
Philopotamidae	<i>Hydrobiosella</i>	2	0	15	15	17	8	48	89
Ecnomidae	<i>Ecnomina</i>	4	1	3	14	11	6	27	73
Glossosomatidae	<i>Agapetus</i>	0	0	3	9	11	0	19	83
Hydroptilidae	<i>Orphinotrichia</i>	0	1	2	6	6	1	14	70
Leptoceridae	<i>Notalina</i>	5	1	5	8	4	0	15	100
Leptoceridae	<i>Triplectides</i>	3	1	7	11	12	7	14	56

SE-mainland Australia (S-Qld, NSW, Victoria, SA) faunal elements include 23 families, 89 genera and 406 species, with 71% of species endemic. The most speciose three families, Leptoceridae (80), Hydroptilidae (63) and Ecnomidae (59), total 202 species and comprise about 50% of the total.

The fauna of SE mainland Australia can be divided into four component states/substates.

S-Qld: 14 families, 46 genera and 137 species, with 26% of species endemic. The most speciose three families, Leptoceridae (37), Ecnomidae (26) and Hydroptilidae (20), with a combined

83 species, comprise 61% of the total.

NSW (including the Australian Capital Territory [ACT]): 23 families, 78 genera and 263 species, with 31% of species endemic. The most speciose three families, Leptoceridae (47), Hydroptilidae (38) and Ecnomidae (33), with a combined 118 species, comprise 45% of the total.

Victoria: 23 families, 74 genera and 247 species, with 30% of species endemic. The most speciose three families — Leptoceridae (54), Hydroptilidae (41) and Ecnomidae (33), with a combined 128 species, comprise 52% of the total.

SA: nine families, 24 genera and 42 species, with 7% of species endemic. The most speciose three families, Leptoceridae (15), Hydroptilidae (12) and Ecnomidae (7), with a combined 34 species, comprise 81% of the total.

Tasmania faunal elements include 22 families, 71 genera and 195 species, with 57% of species endemic. The most speciose three families, Leptoceridae (35), Hydrobiosidae (33) and Hydroptilidae (22), with a combined 90 species, comprise 46% of the total.

S-WA faunal elements include ten families, 27 genera and 49 species, with 73% of species endemic. The most speciose three families, Leptoceridae (21), Ecnomidae (9) and Hydroptilidae (8), with a combined 38 species, comprise 78% of the total.

*Central Australia (Pilbara region of N-WA, S-NT, SW-Qld, W-NSW, N-SA) or Eyrean Province.* Only four Trichoptera families, containing some 29 species, are known from this large province: Leptoceridae (genera *Oecetis* and *Tripletides*), and other widely distributed families including Ecnomidae (*Ecnomus* – 7 species, 3 in the Pilbara, 4 in central Australia, among them 3 that have predominantly a Bassian distribution – *E. continentalis*, *E. pansus* and *E. turgidus*), Hydropsychidae (*Cheumatopsyche*), three species of Hydroptilidae (2 species of *Hellyethira* and 1 species of *Orthotrichia*) and two species of Philopotamidae (*Chimarra*) (see Table 8). Only four species – *Ecnomus ingibandi* Cartwright, *Chimarra luminaris* Cartwright, *C. yoolumba* Cartwright and *O. glebula* Wells – are endemic to the Pilbara; another ecnomid (*Ecnomus centralis*) is endemic to central Australia.

Pilbara region faunal elements include 21 species: 13 Leptoceridae (8 spp *Oecetis*, 2 spp. *Triaenodes*, 3 spp. *Tripletides*), 2+ species Hydroptilidae (one species each of *Hellyethira* and *Orthotrichia*), three species of *Ecnomus* (with one endemic), two species of *Chimarra* and one species of *Cheumatopsyche*.

*Faunal provinces.* Spencer (1896) first proposed the concept of three Australian faunal provinces based on a limited knowledge of some animal groups. Neboiss (1981) summarised some of the modifications to this, based on vegetation, rainfall and concepts of faunal barriers and refuge areas. Neboiss (1988) followed the

standard system adopted for the Australian Biological Resources *Zoological Catalogue of Australia* series, assigning fauna to the main drainage basins (Fig. 2). More recently, the Australian Government adopted as standard the Interim Biogeographic Regionalisation for Australia regions for the Australian Biological Resources Study faunal directory (ABRS, 2009) based on Ebach (2012), which are less appropriate for assignment of aquatic organisms. In the present review, we apply a broader approach by defining regions based on political boundaries (i.e., states or territories), with the addition that the two states spanning the greatest range of latitude and climatic variation, WA and Qld, are partitioned into northern and southern regions. Based on our knowledge of the Australian fauna, we divided WA at Barrier 4 (between Geraldton and the Pilbara region; see Fig. 2) and Qld at Barrier 1 (area between Townsville and Rockhampton; see Fig. 2).

*Refuge areas and distributional barriers.* Neboiss (1981) reviewed the concept and characterisation of refuge areas and distributional barriers in Australia. Put simply, refuge areas often support additional animal populations due to more hospitable conditions (such as greater rainfall and diversity of vegetation) than the surrounding land. Distributional barriers for dispersal for many Australian animals are predominantly the numerous arid zones and encircling seas. The following Australian arid areas and marine barriers are somewhat variable in impact, because better-dispersing species, such as some widespread leptocerids (particularly some *Oecetis* and *Tripletides*), *Ecnomus* and *Chimarra* species, commonly span some of these barriers.

East Coast. Barrier 1 (dry area between Townsville and Rockhampton) separating NE Queensland's northern or Torresian fauna (predominantly QWT and Cape York Peninsula) from SE Australia's southern or Bassian fauna. (Note: 21 Trichoptera families are recorded in the QWT, 19 in common with southern Australia. However, only ten northern families are recorded outside the QWT, of which nine also occur within the QWT, therefore, the QWT arguably has a Trichoptera fauna more in common with Australia's southern states than with other northern states/territories).

Table 8. Main families and number of Trichoptera species within central Australia (Eyrean province).

Family	Genus	Central Eyrean	Pilbara Eyrean	Total Eyrean
Leptoceridae	<i>Oecetis</i>	7	8	10
	<i>Tripletides</i>	2	3	3
	<i>Triaenodes</i>	0	2	2
Hydroptilidae	<i>Hellyethira</i>	2	1	3
	<i>Orthotrichia</i>	1	1	1
Ecnomidae	<i>Ecnomus</i>	4	3	7
Hydropsychidae	<i>Cheumatopsyche</i>	0	1	1
Philopotamidae	<i>Chimarra</i>	0	2	2
Total 5 families	Total 8 genera	16	21	29

South Coast. Barrier 2 (Bass Strait) separating SE mainland Australia's fauna from that of Tasmania (with 57% of Tasmanian species being endemic). Barrier 3 (arid Nullabor Plain) separating SE mainland Australia's (SE Bassian) fauna from SW Australia (SW Bassian) fauna (with 73.5% of S-WA species being endemic).

West Coast. Barrier 4 (arid zone between Geraldton and Pilbara region) separating SW Australia (southern or Bassian) fauna from the (northern Eyrean) Pilbara. Barrier 5 (arid zone south of Broome) separating the (Eyrean) Pilbara fauna from NW Australia (Torresian), predominantly Kimberley Region.

North Coast (NC). Barrier 6 (arid zone east of WA–NT border) separating NW Australia (Torresian), principally Kimberley fauna, from (NC Torresian) the “Top End” of the NT. Barrier 7 (dry zone east of NT–Qld border), separating (NC Torresian) the “Top End” fauna of the NT from NE Queensland (Torresian), largely the Wet Tropics and Cape York Peninsula.

Neboiss (1981) stated that refuge areas have more hospitable conditions (presumably over long periods of time), and are usually mountainous areas with high rainfall and diverse vegetation. These criteria apply to much of eastern and south-eastern coastal Australia and, not surprisingly, the eastern and south-eastern states of Qld (especially the northern part), NSW, Victoria and Tasmania have the highest number of caddisfly species (Table 1).

States/regions/subregions with highest biodiversity are NSW with 263 species, Victoria with 246 species and N-Qld with 248 species (incl. QWT with 217 spp/taxa – Walker et al., 1995). The highest endemism is recorded in S-WA, with 73.5% endemic species, followed by N-Qld with 58% and Tasmania with 57%, and lowest in SA with 7%. All other states/regions have endemism levels of 21–31%.

This pattern of biodiversity is somewhat reflected on a much smaller scale, that is, at individual stream sites. The highest number of Trichoptera taxa recorded in Australia in the literature are from Yuccabine Creek in the QWT region of northeastern Queensland, with approximately 80 species reported, followed distantly by Gunshot Creek (Cape York Peninsula) with 47; Franklin River, TWH, with 45; and OShannassy River in central Victoria, with 40-odd species (see Table 9). Walker et al. (1995) provided further evidence that the QWT area is a high diversity or refuge area, reporting that the ten most speciose sites within the QWT averaged nearly 42 taxa.

#### *Potential future studies or considerations on Australian caddisflies.*

During the early scoping of this review, we expanded our thinking to filling perceived information gaps in other areas of caddisfly studies, which may lead to some of the following possible outcomes, in increasing order of wishful thinking.

1. *Continue as is.* Unfortunately, reviews like this are never complete for long. No sooner are they written than they are out of date. We have papers underway describing new species and genera.
2. *Embrace new technology.* Our current analysis of the DNA of Australian Trichoptera using the Biodiversity Of Life Database (BOLD) program is producing exceptional results. Information from interim BOLD DNA results will lead to improved identification of individual or complex species, both for expert and novice taxonomists. DNA information will also enable association of adults and larvae. Biological monitoring using DNA is feasible (Shackleton et al., 2021) and is likely to improve our knowledge of the ecology and distribution of caddisflies.
3. *Update Neboiss's (1992a) key for adult Trichoptera.* This key needs amending to include new families and genera and incorporate changes caused by the increase in diversity of species and increased understanding of morphology.
4. *Update web-based keys for adults and larvae.* The web-based key for identification of larvae produced by Gunn et al. (1999), and that in *The bug guide* (Hawking et al., 2009), are based on existing keys and therefore require upgrades.
5. *A web page.* An Australian caddis website, with updated information on Australian caddisfly research, publications and links to useful sites, would be an extremely useful research resource.
6. *Production of an updated atlas of Australian–SW Pacific Trichoptera.* Due to the almost doubling of Australian species since the first atlas in 1986 (Neboiss, 1986b), the usefulness of this publication has declined. It will be difficult to produce an atlas of all species, and any update will presumably include only new species and updated names or distributions for the species in the original atlas. It may also have to be confined to Australia and not include the SW Pacific.

Table 9. Australian stream sites with highest number of Trichoptera taxa listed in the literature.

Site	State	Families	Genera	Species
Yuccabine Ck	NE Qld	15	39	78+–83*
Gunshot Ck	NE Qld	9	21	47*
Franklin R	Tas			45+
OShannassy R	EC Vic	13	30	40#–44+

Sources: \* Wells and Cartwright (1993a), # Dean and Cartwright (1987), + at Roaring Ck in Walker et al. (1995).

7. *Production of a pictorial e-book.* This could consist of photos or illustrations with a single species per page, including adults and larvae, in typical habitats and with brief biological and ecological information. This would have to cover just a selection of species.

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**Supplementary Table**

Supplementary Table 1. A list of Trichoptera families, numbers of described genera (1983 checklist and 2022) and species (family totals in red) recorded in Australian states/territories/regions.

Family/Genus	SPP	#GENERA 2022 (1981)	S-WA	N-WA	NT	N-Qld	S-Qld	NSW	Vic	Tas	SA
<b>Glossosomatidae</b>	<b>23</b>	<b>1(2)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>4</b>	<b>1</b>	<b>13</b>	<b>12</b>	<b>3</b>	<b>0</b>
<i>Agapetus</i> Curtis, 1834	23		0	0	0	4	1	13	12	3	0
<b>Hydrobiosidae</b>	<b>67</b>	<b>15(14)</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>8</b>	<b>27</b>	<b>29</b>	<b>33</b>	<b>2</b>
<i>Allobiosis</i> Mosely, 1953	1		0	0	0	0	0	1	0	0	0
<i>Allochorema</i> Mosely, 1953	2		0	0	0	0	0	1	1	1	0
<i>Apsilochorema</i> Ulmer, 1907	4		1	0	0	2	2	3	2	2	0
<i>Austrochorema</i> Mosely, 1953	10		0	0	0	0	0	6	5	1	1
<i>Ethochorema</i> Neboiss, 1977	7		0	0	0	0	2	3	3	3	0
<i>Ipsobiosis</i> Neboiss, 1977	1		0	0	0	0	0	0	0	1	0
<i>Koetonga</i> Neboiss, 1962	1		0	0	0	0	0	1	1	1	0
<i>Megogata</i> Neboiss, 1962	1		0	0	0	0	0	1	1	0	0
<i>Moruya</i> Neboiss, 1962	3		0	0	0	0	0	0	0	3	0
<i>Poecilochorema</i> Schmid, 1989	6		0	0	0	0	0	0	0	6	0
<i>Psyllobetina</i> Banks, 1939	5		0	0	0	0	1	2	4	0	0
<i>Ptychobiosis</i> Neboiss, 1977	4		0	0	0	0	1	2	0	1	0
<i>Tanjilana</i> Neboiss, 1962	2		0	0	0	0	0	1	2	0	0
<i>Taschorema</i> Mosely, 1936	11		1	0	0	0	0	+	3	8	1
<i>Ulmerochorema</i> Mosely, 1953	9		0	0	0	1	2	6	7	6	0
<b>Hydroptilidae</b>	<b>162</b>	<b>15(14)</b>	<b>8</b>	<b>27</b>	<b>44</b>	<b>58</b>	<b>20</b>	<b>38</b>	<b>41</b>	<b>22</b>	<b>12</b>
<i>Acanthotrichia</i> Wells, 1982	1		0	0	0	0	1	1	1	0	0
<i>Acritoptila</i> Wells, 1982	6		2	0	0	2	1	1	0	0	0
<i>Austratrichia</i> Wells, 1982	1		0	0	0	0	0	0	1	0	1
<i>Chrysotrichia</i> Schmid, 1958	1		0	0	0	1	0	0	0	0	0
<i>Helyethira</i> Neboiss, 1977	30		2	9	10	13	3	7	7	5	4
<i>Hydroptila</i> Dalman, 1819	11		1	1	2	3	4	5	6	4	3
<i>Jabirtrichia</i> Wells, 1990	1		0	0	1	1	0	0	0	0	0
<i>Maydenoptila</i> Neboiss, 1977	8		1	0	0	1	1	2	4	3	1
<i>Mulgravia</i> Wells, 1982	2		0	0	0	1	0	1	0	0	0
<i>Orphninoirichia</i> Mosely, 1934	20		0	0	1	4	1	9	7	2	1
<i>Orthotrichia</i> Eaton, 1873	55		0	12	18	23	7	9	12	2	1
<i>Oxyethira</i> Eaton, 1873	18		2	1	5	6	1	3	2	5	1
<i>Scelotrichia</i> Ulmer, 1951	1		0	0	0	1	0	0	0	0	0
<i>Tricholeiochiton</i> Kloet&Hincks,1944	6		0	4	4	2	0	0	0	1	0
<i>Xuthotrichia</i> Mosely, 1934	1		0	0	0	0	1	1	1	0	0

Family/Genus	SPP	#GENERA 2022 (1981)	S-WA	N-WA	NT	N-Qld	S-Qld	NSW	Vic	Tas	SA
<b>Philopotamidae</b>	<b>82</b>	<b>2(2)</b>	<b>2</b>	<b>10</b>	<b>7</b>	<b>17</b>	<b>12</b>	<b>20</b>	<b>17</b>	<b>16</b>	<b>0</b>
<i>Chimarra</i> Stephens, 1829	28		0	10	7	10	4	3	2	1	0
<i>Hydrobiosella</i> Tillyard, 1924	54		2	0	0	7	8	17	15	15	0
<b>Stenopsychidae</b>	<b>9</b>	<b>1(1)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>6</b>	<b>3</b>	<b>1</b>	<b>0</b>
<i>Stenopsychodes</i> Ulmer, 1916	9		0	0	0	2	0	6	3	1	0
<b>Dipseudopopsidae</b>	<b>1</b>	<b>1(0)</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<i>Hyalopsyche</i> Ulmer, 1904	1		0	0	1	1	0	0	0	0	0
<b>Ecnomidae</b>	<b>126</b>	<b>7(2)</b>	<b>9</b>	<b>31</b>	<b>34</b>	<b>38</b>	<b>26</b>	<b>33</b>	<b>33</b>	<b>10</b>	<b>7</b>
<i>Absensomina</i> Cartwright, 2010	1		0	0	0	1	0	0	0	0	0
<i>Austrotinodes</i> Schmid, 1955	11		0	0	0	6	1	3	1	0	0
<i>Daternomina</i> Neboiss, 2003	16		3	0	0	3	3	4	5	3	0
<i>Ecnomina</i> Kimmins, 1953	37		4	1	2	7	6	11	14	3	1
<i>Ecnomus</i> McLachlan, 1864	40		2	21	23	16	14	15	13	4	6
<i>Neboissomina</i> Cartwright, 2011	8		0	1	2	3	2	0	0	0	0
<i>Wellsomina</i> Cartwright, 2010	13		0	8	7	2	0	0	0	0	0
<b>Hydropsychidae</b>	<b>55</b>	<b>9(8)</b>	<b>2</b>	<b>4</b>	<b>5</b>	<b>20</b>	<b>16</b>	<b>16</b>	<b>12</b>	<b>10</b>	<b>1</b>
<i>Aethaloptera</i> Brauer, 1875	1		0	0	0	1	0	0	0	0	0
<i>Asmicridea</i> Mosely, 1953	3		0	1	1	1	1	1	1	2	0
<i>Arcyphysa</i> Wells & Neboiss, 2018	20		0	0	0	10	7	3	1	0	0
<i>Austropsyche</i> Banks, 1939	6		0	0	0	0	2	5	3	0	0
<i>Baliomorpha</i> Neboiss, 1984	4		0	0	0	1	3	2	2	0	0
<i>Cheumatopsyche</i> Wallengren, 1891	9		1	3	4	4	1	3	2	3	1
<i>Diplectrona</i> Westwood, 1840	6		0	0	0	1	2	2	2	3	0
<i>Macrostemum</i> Kolenati, 1859	1		0	0	0	1	0	0	0	0	0
<i>Smicrophylax</i> Neboiss, 1977	5		1	0	0	1	0	0	1	2	0
<b>Polycentropodidae</b>	<b>21</b>	<b>5(7)</b>	<b>2</b>	<b>2</b>	<b>6</b>	<b>7</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>7</b>	<b>0</b>
<i>Adectophylax</i> Neboiss, 1982	1		1	0	0	0	0	0	0	0	0
<i>Neureclipsis</i> McLachlan, 1864	1		0	0	0	0	0	1	1	0	0
<i>Nyctiophylax</i> Brauer, 1865	8		0	1	4	5	0	0	0	1	0
<i>Plectrocnemia</i> Stephens, 1836	8		1	0	0	1	0	1	1	5	0
<i>Polypsectropus</i> Ulmer, 1905	3		0	1	2	1	0	1	1	1	0
<b>Psychomyiidae</b>	<b>3</b>	<b>2(2)</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<i>Tinodes</i> Curtis, 1834	2		0	0	1	2	0	0	0	0	0
<i>Zelandoptila</i> Tillyard, 1924	1		0	0	0	1	0	0	0	0	0

Family/Genus	SPP	#GENERA 2022 (1981)	S-WA	N-WA	NT	N-Qld	S-Qld	NSW	Vic	Tas	SA
<b>Limnephilidae</b>	2	1(1)	0	0	0	0	0	1	2	1	0
<i>Archaeophylax</i> Kimmins, 1953	2		0	0	0	0	0	1	2	1	0
<b>Oeconesidae</b>	1	1(1)	0	0	0	0	0	0	0	1	0
<i>Tascuna</i> Neboiss, 1975	1		0	0	0	0	0	0	0	1	0
<b>Plectrotarsidae</b>	5	3(3)	1	0	0	0	0	1	1	4	0
<i>Liapota</i> Neboiss, 1959	1		0	0	0	0	0	0	0	1	0
<i>Nanoplectrus</i> Neboiss, 1977	1		0	0	0	0	0	0	0	1	0
<i>Plectrotarsus</i> Kolenati, 1848	3		1	0	0	0	0	1	1	2	0
<b>Atriplectididae</b>	2	1(1)	1	0	0	2	0	1	1	1	1
<i>Atriplectides</i> Mosely, 1936	2		1	0	0	2	0	1	1	1	1
<b>Calamoceratidae</b>	10	1(1)	0	2	2	5	2	3	3	1	1
<i>Anisocentropus</i> McLachlan, 1863	10		0	2	2	5	2	3	3	1	1
<b>Kokiriidae</b>	5	3(3)	0	0	0	0	0	0	2	3	0
<i>Tanjistomella</i> Neboiss, 1974	1		0	0	0	0	0	0	1	0	0
<i>Taskiria</i> Neboiss, 1977	3		0	0	0	0	0	0	1	2	0
<i>Taskiropsyche</i> Neboiss, 1977	1		0	0	0	0	0	0	0	1	0
<b>Leptoceridae</b>	180	15(14)	21	42	51	72	37	47	54	33	15
<i>Hudsonema</i> Mosely, 1936	2		1	0	0	0	0	1	1	1	1
<i>Lectrides</i> Mosely, 1953	2		1	0	0	0	1	1	1	1	0
<i>Leptocerus</i> Leach, 1815	4		0	0	1	3	2	0	1	0	1
<i>Leptorussa</i> Mosely, 1953	1		0	0	0	0	0	1	1	1	1
<i>Notalina</i> Mosely, 1936	15		5	0	0	0	1	5	8	6	1
<i>Notoperata</i> Neboiss, 1977	5		3	0	0	0	0	1	2	2	0
<i>Oecetis</i> McLachlan, 1877	67		5	26	32	36	18	21	16	11	7
<i>Russobex</i> St Clair, 1988	1		0	0	0	0	0	0	1	0	0
<i>Setodes</i> Rambur, 1842	1		0	0	0	1	0	0	0	0	0
<i>Symphitoneuria</i> Ulmer, 1906	4		1	0	0	1	1	1	0	1	1
<i>Trienodes</i> McLachlan, 1865	48		1	11	13	18	5	3	9	1	2
<i>Triplectides</i> Kolenati, 1859	25		3	5	5	11	7	12	11	7	1
<i>Triplectidina</i> Mosely, 1936	1		0	0	0	0	0	0	1	1	0
<i>Triplexa</i> Mosely, 1953	1		0	0	0	0	1	0	0	0	0
<i>Westriplectes</i> Neboiss, 1977	3		1	0	0	0	1	0	2	1	0

Family/Genus	SPP	#GENERA 2022 (1981)	S-WA	N-WA	NT	N-Qld	S-Qld	NSW	Vic	Tas	SA
<b>Odontoceridae</b>	<b>11</b>	<b>2(2)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>7</b>	<b>1</b>	<b>1</b>	<b>0</b>
<i>Barynema</i> Banks, 1939	8		0	0	0	2	3	5	1	0	0
<i>Marilia</i> F. Müller, 1878	3		0	0	0	0	0	2	0	1	0
<b>Philorheithridae</b>	<b>15</b>	<b>5(5)</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>5</b>	<b>7</b>	<b>11</b>	<b>0</b>
<i>Aphilorheithrus</i> Mosely, 1936	4		0	0	0	0	0	1	1	4	0
<i>Austrheithrus</i> Mosely, 1953	3		0	0	0	0	0	2	3	2	0
<i>Kosrheithrus</i> Mosely, 1953	3		1E	0	0	0	0	1	2	1	0
<i>Ramiheithrus</i> Neboiss, 1974	2		0	0	0	0	0	1	1	1	0
<i>Tasmanthrus</i> Mosely, 1936	3		0	0	0	0	0	0	0	3	0
<b>Antipodoeciidae</b>	<b>1</b>	<b>1(1)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>
<i>Antipodoecia</i> Mosely, 1934	1		0	0	0	1	1	1	1	0	0
<b>Calocidae</b>	<b>32</b>	<b>6(3)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>7</b>	<b>3</b>	<b>13</b>	<b>11</b>	<b>5</b>	<b>0</b>
<i>Caenota</i> Mosely, 1953	7		0	0	0	3	1	3	1	1	0
<i>Caloca</i> Mosely, 1953	13		0	0	0	0	0	5	6	3	0
<i>Calocoides</i> Neboiss, 1984	3		0	0	0	1	0	2	0	0	0
<i>Latarima</i> Shackleton, 2014	2		0	0	0	0	0	0	2	0	0
<i>Pliocaloca</i> Neboiss, 1984	5		0	0	0	3	2	1	0	0	0
<i>Tamasia</i> Mosely, 1936	2		0	0	0	0	0	2	2	1	0
<b>Chathamidae</b>	<b>2</b>	<b>2(1)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>
<i>Chathamia</i> Tillyard, 1925	1		0	0	0	0	0	1	0	0	0
<i>Philanisis</i> Walker, 1852	1		0	0	0	0	0	1	1	0	0
<b>Conoesucidae</b>	<b>23</b>	<b>6(6)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>7</b>	<b>6</b>	<b>19</b>	<b>1</b>
<i>Coenoria</i> Mosely, 1953	1		0	0	0	0	0	1	0	0	0
<i>Conoesucus</i> Mosely, 1936	8		0	0	0	0	0	1	0	7	0
<i>Costora</i> Mosely, 1936	8		0	0	0	0	0	1	2	8	0
<i>Hampa</i> Mosely, 1953	1		0	0	0	0	0	1	1	1	0
<i>Lingora</i> Mosely, 1936	4		0	0	0	0	0	2	2	2	1
<i>Matasia</i> Mosely, 1936	1		0	0	0	0	0	1	1	1	0
<b>Heloccabucidae</b>	<b>1</b>	<b>1(0)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>
<i>Heloccabus</i> Neboiss, 2002	1		0	0	0	0	1	1	1	0	0
<b>Helicophidae</b>	<b>7</b>	<b>2(2)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>5</b>	<b>2</b>	<b>5</b>	<b>0</b>
<i>Alloecella</i> Banks, 1939	3		0	0	0	0	0	1	1	3	0
<i>Helicopha</i> Mosely, 1953	4		0	0	0	0	1	3	0	2	0

Family/Genus	SPP	#GENERA 2022 (1981)	S-WA	N-WA	NT	N-Qld	S-Qld	NSW	Vic	Tas	SA
<b>Helicopsychidae</b>	15	1(2)	0	2	2	6	5	7	5	2	0
<i>Helicopsyche</i> Siebold, 1856	15		0	2	2	6	5	7	5	2	0
<b>Tasimiidae</b>	7	2(2)	0	0	0	1	2	6	5	4	1
<i>Tasiagma</i> Neboiss, 1977	2		0	0	0	1	1	2	1	1	0
<i>Tasimia</i> Mosely, 1936	5		0	0	0	0	1	4	4	3	1
<b>Australian total</b>	868	111	49	118	153	248	138	263	247	195	42
% endemics	98		7	21	25	58	25	31	30	57	7

Notes on distribution tables and abbreviated references.

Distribution records for each species are based mainly on published adult records, supplemented by published larval records (+ = unpublished record). The distribution records are based on state and territory boundaries. Abbreviations are WA = Western Australia (N and S), NT = Northern Territory, Qld = Queensland (N and S), NSW = New South Wales (ACT = Australian Capital Territory, here included under NSW), Vic = Victoria, Tas = Tasmania and SA = South Australia (see Fig. 2).



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## New occurrence of Poraniidae (Valvatacea, Asteroidea) in Australia with a new genus and species from deep-sea settings

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### Abstract

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The Poraniidae (Asteroidea, Valvatacea) is recorded for the first time from Australian waters at deep-sea (>200 m) depths, including, at present, Australia's deepest known asteroid occurrence from 3850 m. Three genera are reviewed, each represented by a single species, *Poraniomorpha tartarus* n. sp., *Marginaster paucispinus* Fisher 1913, and *Marginaster patriciae* McKnight 2006, which is reassigned to the new genus, *Bathymarginaster*. Comparisons with other asteroid groups similar to the Poraniidae in Australian waters is made and a key to genera of the Poraniidae is provided.

### Keywords

deep-sea, Australia, abyss, *Poraniomorpha*, *Marginaster*

### Introduction

Undiscovered biodiversity in marine Australian habitats, especially in deep-sea settings, is substantial, estimated at 250,000 species (Butler et al., 2010). Since Rowe and Gates (1995), no more than 14 new species have been described from Australian waters (Mah, 2006; Benavides-Serrato and O'Loughlin, 2007; Marsh, 2009; Naughton and O'Hara, 2009); most resulted from revisions of the shallow-water Asterinidae (O'Loughlin, 2002; O'Loughlin et al., 2003; Dartnall et al. 2003; O'Loughlin, 2009; O'Loughlin and Bribiesca-Contreras, 2015). Australian asteroid faunas from shallow nearshore settings have been more extensively documented (e.g. Clark, 1921, 1946; Marsh and Fromont, 2020) than those from deeper waters; for example, only 12 of 211 species recorded by Rowe and Gates (1995) were from below 1000 m. Since 1995, only three new species have been described from Australian deep-sea settings (<200 m) (Mah, 2006).

To improve understanding of this fauna, deep-water and offshore environments around Australia have been surveyed (e.g. O'Hara et al., 2020), resulting in new discoveries (e.g. Ekins et al., 2020; Zhang et al. 2020) and better characterisation of Australian biodiversity, especially for deep-sea settings.

Certain shallow-water asteroids are “keystone species” that affect community structure. Examples include *Pisaster ochraceus*, which preys on mollusks in temperate-cold-water systems (e.g. Paine 1966, 1969), and the crown-of-thorns sea star (*Acanthaster* spp.), which preys on coral reefs (e.g. Branham, 1973; Birkeland and Lucas 1990). Deep-water ecosystems are not well documented, but accounts from

remotely operated vehicles report corals and sponges as “ecosystem engineers” serving as hosts for a diversity of associates that form the basis of communities, often seen as “oases” amidst low-diversity settings (Buhl-Mortensen et al., 2010). Predation on corals and sponges by deep-sea asteroid taxa is an important consideration in understanding their ecology (Mah, 2020).

National Oceanic and Atmospheric Administration (NOAA) ship *Okeanos Explorer* has observed multiple predatory members of the Poraniidae at 300–3740 m, including *Poraniomorpha abyssicola*, *Marginaster pectinatus* and *Chondraster* sp. feeding on sponges, and corals in the North Atlantic (Mah 2020). *Bathyporania ascendens* was observed feeding on black coral (Antipatharia) at 2669 m in the North Pacific (Mah and Foltz, 2014). Although not observed at the same frequency or abundance as members of the Hippasterinae (Goniasteridae) (Mah, 2020, 2022) *Okeanos Explorer* regularly encountered poraniids in deep-sea settings in the North Atlantic (Mah, personal observation), suggesting unrecognised broader significance in similar habitats elsewhere.

The Poraniidae are a small family of Valvatacea that includes 11 living and one fossil genus. The family is known primarily from deep waters in cold to temperate water settings, especially at high latitudes (Mah and Foltz, 2014). Phylogenetic analysis (Mah and Foltz, 2011) unexpectedly showed the Poraniidae to be part of a basal dichotomy, and thus a sister group to the highly diverse Valvatida. Phylogenetic positioning was consistent with *Noriaster*, the fossil poraniid described from the Triassic (Blake et al., 2000).

Relatively few Poraniidae are known from the Southern Hemisphere. The high-latitude/Antarctic *Glabraster antarctica* (Smith, 1876) and two South African species, *Chondraster elattosis* H.L. Clark, 1923 and *Spoladaster veneris* (Perrier, 1879) with *Spoladaster brachyactis* (Clark, 1923) and *Tylaster meridionalis* Mortensen, 1933 having been synonymised with *S. veneris* according to Mah and Foltz (2014).

The species described herein are the first three accounts of the Poraniidae known from Australian waters. In Australia, the Poraniidae was historically represented by a single species, *Marginaster littoralis* Dartnall 1970 (Rowe and Gates, 1995). This was found to have been a misidentified species in the Asterinidae (Mah and Foltz, 2014; O'Hara et al., 2018). The three Poraniidae species presented herein are the first known from Australian waters.

A museum survey of asteroid specimens at the Museum Victoria in Melbourne, Australia revealed multiple new Poraniidae records from deep-water collections (>150 m). Poraniidae were not reported from earlier studies of Australian waters, such as Rowe and Gates (1995), Mah and Foltz (2014) and O'Hara et al. (2018), so these new taxa add to our understanding of the local marine fauna.

## Methods and materials

Specimens described herein are deposited in the collections of the Museum Victoria (NMV) in Melbourne, Australia, the Muséum national d'Histoire naturelle (MNHN) in Paris and the Department of Invertebrate Zoology in the National Museum of Natural History (USNM) in Washington, D.C.

Taxonomic conventions follow the phylogenetic conclusions of Mah and Foltz (2011) and Linchangco et al. (2017). Measurements of specimens listed below are in centimetres. As a matter of convention, "R" is the distance from the disk centre to the arm tip (measured from the underside) and "r" is the distance from the disk centre to the disk edge. R/r is a ratio with no units.

## Systematics

### ASTEROIDEA de Blainville 1830

### VALVATACEA Blake 1987

### PORANIIDE Perrier 1893

Asterinidae (pt) Gray 1840: 288 (*Porania*).—Viguier 1878: 683.—1879: 220.—Perrier 1891: K107, 163

Goniasteridae (pt) Perrier 1875: 185[1876:11]

Gymnasteridae (pt) Perrier 1884: 165, 168, 229.—Sladen 1889: 355.—Verrill 1895: 137.

Poraniidae Perrier 1893: 849.—1894: 163–164.—Verrill 1914: 17.—1915: 68.—Fisher 1919: 407.—Clark 1923: 274.—Mortensen 1927: 89–90.—Fisher 1940: 154.—Djakonov 1950: 57(1968: 48).—Clark 1962: 34.—Bernasconi 1964: 263.—Tortonesi 1965: 166.—Spencer and Wright 1966 (pt): U69.—Downey 1973: 81.—Hotchkiss and A.M. Clark 1976: 263–266.—Clark and Courtman-Stock 1976: 73.—Blake 1981: 380–381.—Tablado 1982: 88.—Clark 1984: 20–49.—Clark and McKnight 2001: 165.—Mah and Foltz 2014: 330.

Gymnasteridae Bell 1893: 21, 78.—Ludwig 1900: 459.—Farran 1913: 16.

Asteropidae (pt) Fisher 1911: 247–248.

Asteropidae Koehler 1921: 40–41.—1924: 151.—Mortensen 1933: 249.—Fisher 1940: 136.

**Diagnostic comments.** Prior detailed accounts summarise diagnoses for the Poraniidae (e.g. Clark, 1984; Clark and Downey, 1992). The account herein diagnoses the group within a more recent context, following the molecular phylogenetic treatment by Mah and Foltz (2014), which also emphasised skeletal morphology, especially those features observed on dried specimens. The diagnosis herein considers newly described genera, *Bathyporania* and *Claviporania*, as well as the reinstatement of *Glabraster* for "*Porania*" *antarctica*.

Examination of the Poraniidae in this context has compelled re-evaluation of assumed character states from the taxonomic literature. Clark and Downey (1992) and Clark (1984) used the term "resorption" in conjunction with conclusions regarding decalcification (Clark and Downey 1992) in *Culcitopsis*, which possesses a thick fleshy body wall. Composition and developmental understanding of these characters is poorly understood and further study is desirable. As best as possible, terminology herein is limited to descriptive terms, avoiding interpretations pending further understanding of these characters.

**Diagnosis.** Body form pentagonal to stellate, with weakly curved to straight interradiar arcs. Disk and arms thick, strongly arched in many taxa, nearly all genera covered by a thick, fleshy, often stout dermis or tissue overlying the endoskeleton, which in most taxa completely obscures any plate patterns or outlines. Abactinal plate morphology variable, ranging from bar-like to more irregularly thickened and mound-like. Prominent spines present in *Poraniopsis* and variably in *Glabraster*, but otherwise the thick dermis or tissue is variably smooth or covered by granules, spinelets or other accessories. In taxa such as *Poraniomorpha* or *Glabraster*, dried specimens reveal a closely imbricate, reticulate or fenestrate skeleton overlain by the aforementioned tissue or dermis. Spines (e.g. *Poraniopsis*) or prominent knobbed projections (e.g. *Clavaporania*) variably present on abactinal and marginal plates. Marginal plates, when not obscured by dermis or tissue, appear to be imbricate but quadrate to blocky in shape.

Actinal plates variable, transversely rod-like to forming irregularly imbricate pavement. Adambulacral and other prominent marginal or actinal spination are similarly covered by a fleshy dermis or tissue. Furrow spines generally few (1–3). Pedicellariae absent.

**Comments.** Poraniids superficially appear similar to another family of Australian asteroids, the Asteropseidae, including *Petricia* and *Asteropsis*, which also have a layer of dermis or tissue covering their endoskeleton but occur primarily in shallow-water temperate to tropical settings. Hotchkiss and Clark (1976) addressed this issue, separating the two families that Spencer and Wright (1966) had merged, outlining morphological differences. Molecular data (e.g. Mah and Foltz, 2011) further supported separation between these groups.

Actinal plates are a useful diagnostic character for distinguishing the Poraniidae from the Asteropseidae (Hotchkiss and Clark, 1976; Clark, 1984). Asteropseid actinal plates are quadrate to polygonal in shape and arranged in a chevron-like arrangement. Poraniid actinal plates are arranged

in a transverse pattern from the lateral edge to the ambulacral groove. Marginal plate arrangements can be similarly diagnostic, with asteropseids showing abutted plates whereas poraniids show more fenestrate to imbricate arrangements.

Further members of the Valvatida that could be confused with the Poraniidae include the mesophotic oreasterid, *Astrosarkus* Mah, 2003 and asterinids such as *Disasterina* Perrier, 1875, which also show a thick fleshy body wall and/or a thickened dermal layer covering the body surface. *Astrosarkus* is most immediately distinguished from any poraniid by the presence of pedicellariae, with a continuous granular covering and adambulacral spines that are primarily blunt tipped, thick and present in multiple rows. Pedicellariae have not been observed on poraniids, which show pointed adambulacral spines with a well-developed dermal sheath. *Astrosarkus* also shows a broad lateral surface, whereas most poraniids display a more rounded lateral edge.

The asterinid *Disasterina*, including *D. abnormalis* Perrier 1875, possess a well-developed dermal covering over the abactinal, marginal and actinal plates on wet preserved and living specimens, which in some instances can cause them to resemble poraniids. Plate patterns in dried *Disasterina* are well developed, and plate shape and abundance is very different from those in any of the Poraniidae. *Disasterina* also occur primarily in shallow-water settings (intertidal to 3 m) (Marsh and Fromont, 2020).

### Key to the Poraniidae

- (0) Prominent spines present on abactinal, marginal surface. Skeleton reticulate. .... (1)
- (0') Spines (if present) small and conical; otherwise, abactinal and marginal surface covered by thickened dermis, granules with round to pointed tips and/or round granules. .... (2)
- (1) Spines pointed. Dermis with ossicles or spinelets present or absent. Reticulation frames large papular regions, each with papulae 10–30. Sub-temperate bands in northern (Russia, Japan, west coast of North America to Galapagos) and southern hemisphere (Patagonian South America, including Brazil, Argentina, etc. southern Indian Ocean). .... *Poraniopsis*
- (1') Spines thickened with bifurcated tips. Dermis on abactinal, lateral and actinal surface invested with a dense covering of tiny spinelets. Papular pores single. Known only from the holotype, Macquarie Island, 1574–1693 m .... *Clavaporania*
- (2) Thickened, fleshy body wall at moderate to large sizes ( $R > 3.0$  cm). Skeletal ossicles not clearly visible externally. .... (3)
- (2') Dermal overlay but skeleton visible, fenestrate to reticulate. .... (5)
- (3) Spinelets in body wall. Abactinal, actinal surface covered by numerous superficial spinelets. Inferomarginal plates with spinelets or spines. Papulae present but inconspicuous. South Africa and southern Indian Ocean. .... *Spoladaster* (*Tylaster* is a possible synonym)
- (3'') Body wall surface smooth and naked. Marginal plates with spines present or absent. Papulae large, conspicuous. .... (4)
- (4) Papulae present in continuous parallel series on adradial sides along arm. Spines variably present on marginal plates. North Atlantic and South Africa. .... *Chondraster*
- (4'') Papulae in discrete clusters, variably extending completely along arm, or in transverse series on abactinal surface. Spines absent. North Atlantic, North American and European coast. .... *Culcitopsis*
- (5) Skeleton reticulate, thick tissue or dermis variably well developed or present as an overlay obscuring plate boundaries. .... (6)
- (5') Skeleton fenestrate, surface variably covered by granules, which are round or spine-tipped. .... (9)
- (6) Marginal plates per interradius, relatively few, 8–10 per interradius (arm tip to arm tip). Overall, most individuals pentagonal to weakly stellate; size tends to be small, with most individuals with  $R=0.5-1.0$  (diameter approximately 1–2.0 cm). Widely occurring, Atlantic and Pacific. .... *Marginaster*
- (6') Marginal plates numerous, 20–50 per interradius (at approximately  $R=1.2$ ) .... (7)
- (7) Subambulacral spine large, wide and flat. Abactinal surface variably smooth or covered with prominent spines, well-developed dermis covering reticulate plates. Inferomarginal plates with bearing large, flat spines. Known only from Southern Ocean and adjacent waters (Patagonia, etc) .... *Glabraster*
- (7') Subambulacral spines pointed. Abactinal skeleton variably open to more close set, approaching a more fenestrate arrangement in some specimens. .... (8)
- (8) Abactinal, marginal, actinal surface with a rugose appearance, covered by short spines and spinose granules. Abactinal, marginal plates, multi-lobate in shape, superomarginal plates with 2–4 distinct pointed spines. Body stellate ( $R/r=3.1$ ), arms elongate. North Pacific. .... *Bathyporania*
- (8'') No abactinal spines, surface mostly smooth. Abactinal skeleton imbricate, variably reticulate to more close-set, nearly fenestrate. Marginal plates more blocky in shape, imbricate, inferomarginal plates each with 4–6 pointed spinelets. Northern Hemisphere, temperate North Atlantic. .... *Porania*
- (9) Papular pores numerous (3–15). Marginal plates form wide periphery around body, 35–40 per interradius. Body pentagonal to weakly stellate (1.5–2.0). North Atlantic. .... *Poraniomorpha hispidia*
- (9') Papular pores single. Marginal plates number 16–60 per interradius, indistinct with lateral facing. Body form weakly stellate to stellate,  $R/r=1.6-2.5$  arms confluent with disk. .... (10)

- (10) Marginal plates numerous, 48–60 per interradius. Body stellate to strongly stellate,  $R/r=1.9-2.5$  arms distinct with tips tapering to elongate. North Atlantic and *P. tartarus* from Australia. .... *Poraniomorpha abyssicola*, *P. tumida*, *P. bidens* and *P. tartarus*
- (10') Marginal plates number approximately 16 per interradius. Weakly stellate to stellate,  $R/r=1.6-2.1$ , arms distinct, consistently short with rounded tips. South Pacific (New Zealand & Tasmania). .... *Bathymarginaster n. gen.*

### Taxonomic account

#### *Bathymarginaster* nov. gen.

*Diagnosis and comments.* As for species.

*Etymology.* The name alludes to the Greek *bathos* for deep and the type name *Marginaster*, referring to this taxon's presence at great depth (191–1130 m) relative to the other *Marginaster* species.

#### *Bathymarginaster patriciae* (McKnight, 2006) nov. gen, nov. comb.

Figure 1a–f

*Diagnosis.* Body weakly stellate to stellate ( $R/r=1.6-2.1$ ) (Fig. 1a). Body surface, including abactinal, marginal, actinal surface all covered by dermis. Abactinal surface reticulate to imbricate, with coarse granulation/spination on each plate (Fig. 1a, b), single papulae present. Marginal plates lateral facing, approximately 16 per interradius (Fig. 1c), each plate bearing an upper and lower series, each with 2–3 spinelets present, the lower series approximately 2–3 times as large as the upper and present around the actinolateral fringe. Distinct actinolateral edge (Fig. 1e) formed by the inferomarginal plates and the actinal surface. Actinal intermediate region with approximately 16 segments, each with a spine forming a transverse series across each interradius (Fig. 1f). Furrow spines, two covered in dermis (Fig. 1d, f); no other adambulacral spination evident.

*Comments.* Examination of *M. patriciae* specimens relative to other *Marginaster* species, including the holotype of *Marginaster paucispinus*, led to the conclusion that *M. patriciae* is significantly different from other species assigned to *Marginaster*. '*Marginaster*' *patriciae* shows a much more stellate body shape, has a much denser and heavier abactinal skeleton that is weakly fenestrate. This contrasts with the skeleton in more typological *Marginaster* species, which show a more openly arranged mesh with a variably developed dermal covering (Fig. 2). *Marginaster patriciae* has laterally oriented marginal plates that form a distinct ventrolateral edge with the actinal surface, whereas the marginals, especially the inferomarginal plates, of other *Marginaster* species are extended from the superomarginals to form a distinct flattened lateral "ledge" or platform with spines.

*Marginaster patriciae* was originally described from New Zealand waters from near Chatham Rise at 900–1130 m.

Among poraniids, *Bathymarginaster* nov. gen. is perhaps closest to *Poraniomorpha*, which shows a fenestrate skeleton. The abactinal skeleton of the former shows a skeleton with a granular/spinose covering, rather than the more open reticulate skeleton observed in true *Marginaster* species (e.g. Fig. 2a–d). *Bathymarginaster* displays a much heavier dermal overlay (Fig. 1b) than *Poraniomorpha* that obscures the marginal and actinal plate boundaries in the former. *Bathyporania* similarly displays a granular overlay but possesses a more open, reticulate skeleton.

*Occurrence.* Chatham Rise, central New Zealand, 900–1130 m. Note that McKnight (2006: 107) confused the depth range of *M. patriciae* with that of *M. paucispinus* (518–554 m).

Australian waters. J1 Seamount near Tasmania, Great Australian Bight. 850–1650 m.

*Description.* Body thick, strongly arched weakly stellate to stellate ( $R/r=1.6-2.1$ ), arms triangular in shape, cylindrical to triangular in cross-section, actinal surface flat with distinct actinolateral edge. Plates, spines, accessories all covered by dermis (Fig. 1a, b). Arm tips upturned.

Abactinal surface fenestrate to imbricate, skeletal plates individually wide, fully enclosed over disk but forming wider, open spaces distally on arms. Individual plates ranging from larger, more irregular in shape proximally, becoming more crescentic along arms. Each plate with short, blunt spines or granules (4–15, but mostly 7–10), widely spaced, number decreasing distally along arm (Fig. 1b). Single papular pores present irregularly scattered on arms and disk on abactinal and lateral surfaces. Madreporite round, flat, adjacent to abactinal plates and slightly overlaid with tissue around edges.

Marginal plate boundaries largely obscured by dermis, but approximately 16 per interradius, eight per arm side at  $R=1.0$  cm (Fig. 1c, e). At arm tip dermis sufficiently translucent as to reveal elongate plates, edges rounded, decreasing in width adjacent to arm terminus.

Superomarginal and inferomarginal plates each with spines (tips conical and pointed) in upper and lower series, approximately 2–3 in each row. Inferomarginal spines approximately twice as large as those on the superomarginal series, especially those spines on the lower series adjacent to the contact with the actinal plates. Terminal plate quadrate with a circular edge, bearing two small spines.

Actinal plates covered by dermis that shows distinct channels (Fig. 1d, f), forming segments that track from the abactinal-lateral surface via the marginal plates to the underside of the actinal surface around the marginals to each adambulacral plate (Fig. 3e). Actinal surface smooth, dermal tissue continuous from marginal plates. Each actinal intermediate segment has approximately 16 dermis-covered cone-like spines. These are single proximally, becoming double adjacent to the spines on the inferomarginal plates. These spines are in three lateral series across the actinal intermediate region.

Two furrow spines (Fig. 1d, f), covered by dermis in transverse series. No subambulacral or other accessory adambulacral structures. Oral plate with two furrow spines, a single prominent spine projecting into mouth (Fig. 1f).

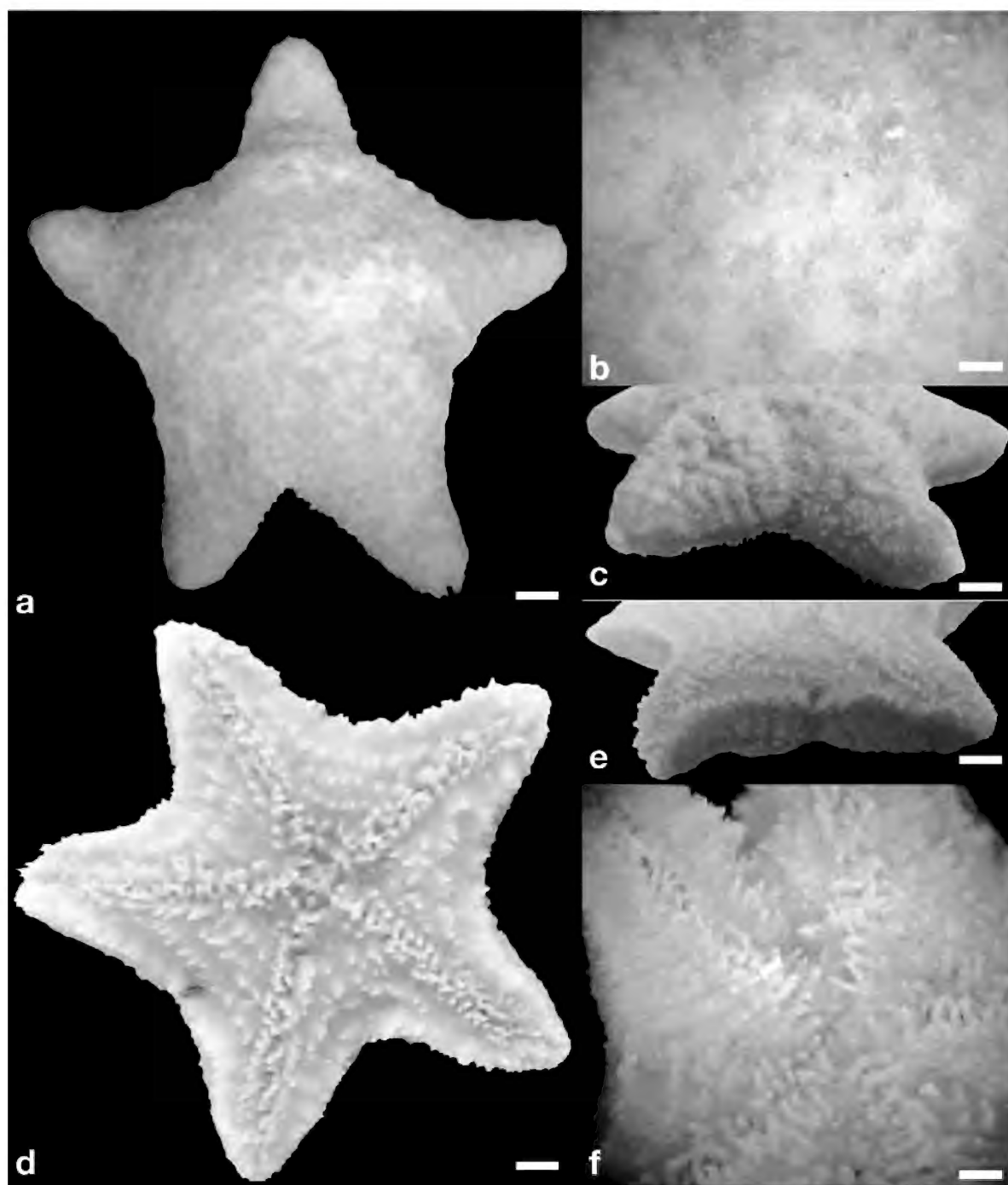


Figure 1. *Bathymarginaster patriciae* nov. gen. nov. comb. NMV F240376: a, abactinal; b, abactinal surface showing granules; c, abactinal-lateral view showing lateral surface, marginal series; d, actinolateral view showing edge and actinal surface; e, actinal view; f, closeup of actinal view showing adambulacral spination, oral view. Scale bars a=3.5 mm, b=1.5 mm, c, f=2 mm, d=2.5 mm, e=3.5 mm.

*Material examined.* NMV F84961 84 km SSE of South East Cape, J1 Seamount, Tasmania. -44.27° S, 147.33° E, 1300–1450 m, Coll. T. Stranks et al. CSIRO, 27 Jan 1997. 1 wet spec. R=1.3, r=0.6.

NMV F159299 Hill U. top west, Tasmania, Australia. -44.3257° S, 147.175° E, 1100–1160 m. Coll. CMAR SS02, April 2 2007. 3 wet specs. R=1.3, r=0.7; R=1.0, r=0.5; R=1.4, r=0.6.

NMV F159300 Pedra West, south of Tasmania, -44.2585° S, 147.092° E, 850–1000 m, Coll. O'Hara et al, CMAR, 2 April 2007, 1 wet specs. R=1.3, r=0.8.

NMV F159301 Mini Matt SSW, Australia. -44.2447° S, 146.164° E, 1120–1136 m. Coll. O'Hara et al, 4 April 2007, CMAR SS02. 3 wet specs. R=1.1, r=0.6; R=1.2, r=0.7; R=1.2, r=0.6.

NMV F159302 Mini Matt site, S. of Tasmania, -44.2439° S, 146.165° E, 1120–1310 m, Coll. O'Hara et al, CMAR 4 April, 2007, 2 wet specs. R=1.1, r=0.6; R=1.3, r=0.7.

NMV F159303 Pedra West, -44.1322° S, 146.144° E, 1140–1180 m, Coll. O'Hara et al. CMAR 5 April 2007, 1 wet spec. R=0.9, r=0.5.

NMV F240386, Great Australian Bight -33.3366° S, 130.257° E, 188–191 m, Coll. IN2015\_C02 GAB BP Expedition – Ichthyology Team, IN2015\_C02 GAB BP Expedition – Marine Invertebrates Team, 15 Dec 2015. 1 wet spec. R=0.6, r=0.4.

NMV F240376, 82.6 km SSE of South East Cape, J1 Seamount, Tasmania, -44.24° S, 147.36° E, 1200–1450 m, Coll. T. Stranks et al. CSIRO, 27 Jan 1997. 4 wet specs. R=1.1, r=0.6; R=1.2, r=0.7; R=1.1, r=0.6; R=1.1, r=0.6.

NMV F241095, 85.8 km SSE of South East Cape, “B1” seamount, -44.31° S, 147.27° E, 1150–1550 m, Coll. T. Stranks et al. CSIRO, 28 Jan 1997. 3 wet specs. R=1.2 r=0.5 R=1.1 r=0.5 R=0.9 r=0.6.

NMV F241096, 87.8 km SSE of South East Cape, “A1” seamount, -44.33° S, 147.27° E, 1200–1300 m, Coll. T. Stranks et al. CSIRO, 30 Jan 1997, 1 wet spec. R=1.1 r=0.5.

NMV F241097, 94.5 km SSE of South East Cape, “V” Seamount, -44.4° S, 147.15° E, 1400–1650 m, Coll. T. Stranks et al. CSIRO, 31 Jan 1997. 1 wet spec. R=1.0 r=0.6

NMV F241098, K1 seamount, 89.5 km SSE of South East Cape, Tasmania, Australia, -44.29° S, 147.41° E, 1225 m, Coll. Tim N. Stranks, CSIRO aboard RV *Southern Surveyor*, 25 Jan 1997. 4 wet specs. R=1.0, r=0.7; R=1.0, r=0.5; R=0.9, r=0.4; R=0.7, r=0.3.

NMV F241099, 81.6 km SSE of South East Cape, “38” seamount, Tasmania. -44.23° S, 147.38° E, 1200–1400 m, Coll. T. Stranks et al. CSIRO 30 Jan 1997, 1 wet spec. R=1.2, r=0.6.

NMV F241100 “Sister I” seamount, 82.9 km SSE of South East Cape, -44.27° S, 147.29° E, 1100–1122 m, Coll. T. Stranks et al. CSIRO, 23 Jan 1997, 2 wet specs. R=1.1, r=0.5; R=1.0, r=0.6.

NMV F241101 “Sister I” seamount, 82.9 km SSE of South East Cape, -44.27° S, 147.29° E, 1100–1122 m, Coll. T. Stranks et al. CSIRO, 1 wet spec. R=1.0, r=0.4

NMV F241102 Mongrel seamount, Tasmania. -44.2554° S, 147.114° E, 898 m. Coll. R. Thrasher and D. Staples, 23 Dec 2008. 1 wet spec. R=1.0, r=0.5.

NMV F241103 Mongrel seamount, Tasmania. -44.2554° S, 147.114° E, 899 m. Coll. R. Thrasher and D. Staples, 13 Oct 2008. 1 wet spec. R=0.4 r=0.2.

NMV F241573 Patience seamount, Huon Commonwealth Marine Reserve, Tasmania, Australia, -44.1206° S, 147.377° E, 1087 m, Coll. D. Bray, RV *Investigator* 12 April 2015. 2 wet specs. R=1.0, r=0.3; R=1.2, r=0.4.

NMV F270826 Punch's Hill, Tasmanian seamounts, Tasmania, -44.185556° S, 147.188333° E, 919–1085 m. Coll. A. Williams, A.A. Weber and R.L. Erickson, 13 Dec 2018. 2 wet specs. R=0.9, r=0.6; R=0.9, r=0.4.

## **Marginaster Perrier 1881**

*Marginaster* Perrier 1881: 16.—1884: 229.—Sladen 1889: 364.—Perrier 1894: 164–165.—Ludwig 1897: 189.—Verrill 1914: 18–19.—1915: 75–76.—Downey 1973: 82.—Clark 1984: 25–27.—McKnight 2006: 106.

*Cheilaster* Bell 1893: 81 (superfluous replacement name for *Marginaster* Perrier)

*Poranisca* Verrill 1914: 19.—Clark 1984: 25 [type: *P. lepidus* Verrill 1914]

*Marginaster* sp. McKnight 1968: 513.—Clark 1970: 5.—Clark and McKnight 2001: 166.

*Type Species.* *Marginaster paucispinus* Fisher 1913 (by subsequent designation)

*Diagnostic comments.* *Marginaster* has historically been considered a “provisional genus” (Clark and Downey, 1992: 205), and as such most recent diagnoses (Clark and Downey, 1992; McKnight, 2006) have been brief and incomplete. This account disagrees with prior accounts that assume *Marginaster* is a juvenile of other poraniid taxa, and as such, attempts to incorporate characters from known species, exclusive of *Marginaster* (now *Bathymarginaster*) *patriciae* and the asterinid *Marginaster* (now *Patiriella*) *littoralis* Dartnall 1970.

*Diagnosis.* Body small, R<2.5 cm, overall shape pentagonal to weakly stellate (R/r=1.4–2.0). Body covered by variably thickened dermis, ranging from relatively thin (Fig. 2a) to very thick and fleshy (Fig. 2e, f). Abactinal plates reticulate, forming widely open papular regions between rod-like ossicles (Fig. 2a, c, d). Plates variably with pointed, conical spinelets. Marginal plates wide, dorsal-facing, forming broad periphery (Fig. 2a, c, d), each plate series bearing 2–6 short spinelets. Inferomarginal spinelets flattened, larger than those on superomarginal plates. Actinal plates imbricate, tissue covered, relatively few overall (Fig. 2b, d, f). One to three short, pointed furrow spines. One to three subambulacral spines.

*Comments.* *Marginaster* Perrier 1881 has been met with skepticism throughout its taxonomic history, beginning with Verrill (1914) and later with Downey (1973) and Clark and Downey (1992), who argued *Marginaster* is the juvenile or small form of a larger, possibly unknown, poraniid. Mah and Foltz (2014) argued that *Marginaster* is a separate but small-sized taxon, and that none of the North Atlantic genera or any of the known Southern Hemisphere poraniidae, such as *Glabraster* at comparable sizes, were morphologically consistent with *Marginaster*. No other known poraniids are distributed with a comparably occurring geographic and/or bathymetric distribution (Mah, unpublished data), making it seem unlikely that *Marginaster* is the juvenile form of some other Poraniidae.

Including *B. patriciae*, addressed herein, there are four known species: *Marginaster capreensis* (Gasco, 1876), *M. paucispinus* Fisher 1913, and *M. pectinatus* Perrier, 1881. *Marginaster capreensis* and *M. pectinatus* occur in the Mediterranean and the Atlantic, whereas *M. paucispinus* occurs in the Pacific and the Indian Ocean (Reunion Island). Although a comprehensive generic review is beyond the scope of the present study, cursory examination suggests relatively few character

differences among species, particularly of inferomarginal spine number and marginal plate number, expression of the reticulate abactinal skeleton and abactinal spination.

### *Marginaster paucispinus* Fisher, 1913

Figure 2a-f

*Marginaster paucispinus* Fisher 1913: 407.—Jangoux and Aziz 1988: 633, 646.—McKnight 2006: 107.—Lee et al. 2017: 274.

*Marginaster* sp. McKnight 1968: 513.—H.E.S. Clark 1970: 5.—McKnight in H.E.S. Clark and McKnight 2001: 166.

**Diagnosis.** Body pentagonal to weakly stellate ( $R/r=1.1-1.7$ ), body thick, arms triangular, interradial arcs weakly curved. Abactinal skeleton reticulate with relatively wide openings (Fig. 2c). Transverse ribs on arms projecting from radial series (Fig. 2a, c). Marginal plates, 10–11 per interradius (Fig. 2a, c, d), each plate with 1–4 short, blunt, conical spinelets (Fig. 2a, b). Superomarginals and inferomarginals (6–7), inferomarginals forming flange-like ambitus, each with 4–5 webbed, flattened spatulate spines. Upper inferomarginal plate surface with 3–4 small spinelets. Actinal plates forming reticulate arrays that track from adambulacral plates to the inferomarginals to the abactinal surface. Open meshes between these plates. Furrow spines (1–2) (Fig. 2b, c), two subambulacral spinelets, narrowly spatulate.

**Comments.** *Marginaster paucispinus* has been widely recorded geographically and in depth (155–700 m) across the Indo-Pacific. Some characteristics – such as marginal plate number and marginal plate spine number, as well as abactinal plate arm patterns – appear to be consistent among individuals surveyed, whereas the two MNHN specimens from the Austral Islands and the South Pacific appear to show a more developed dermal layer. The reticulate skeleton pattern shows a similar pattern to other Indo-Pacific individuals, including the holotype. McKnight (2006) remarked on the similarity between individual *M. paucispinus* and also with other *Marginaster* spp.

This species is distinguished from the Atlantic *Marginaster* species based primarily on the lower marginal plate number per interradius (approximately 10–11) than in *Marginaster pectinatus* (15–20) and *M. capreensis* (approximately 12 or more). Number and position of marginal spines also differed but did show some overlap. A full overview was beyond the scope of this work, but based on taxonomic summaries of these species (e.g. Clark and Downey, 1992), their characteristics are very similar, suggesting further sampling could blur boundaries between established species concepts.

**Occurrence.** Australia. The Great Australian Bight, South Australia, 155–191 m.

Outside Australia. South China Sea, near Hong Kong (183 m), Korea, Reunion Island and Kermadec Islands (179–227 m), northern New Zealand (518–554 m). 179–554 m.

New Records: Austral Islands and the South Pacific, 480–700 m.

**Material examined.** NMV F 240386, Great Australian Bight, South Australia, -33.3366° S, 130.257° E, 188–191 m. Coll. IN2015\_C02 GAB BP Expedition – Ichthyology Team, IN2015\_C02 GAB BP

Expedition – Marine Invertebrates Team. 15 Dec 2015. 1 wet spec.  $R=0.5$ ,  $r=0.3$ .

IE-2013-1518 Austral Islands, northeast of Rapa Its, South Pacific -27.566667° S, 144.27° W, 480–700 m. Coll. BENTHAUS DW 1897. 2 wet spec.  $R=1.6$ ,  $r=1.4$ ;  $R=0.4$ ,  $r=0.35$ .

IE-2013-4675 South Pacific, south of Niue, -25.283333° S, -168.933333° W, 609–691 m. Coll. NORFOLK 2 DW 2064. 1 wet spec.  $R=0.7$ ,  $r=0.4$ .

Holotype, *M. paucispinus*. USNM 32641 Approximately 250 km southeast of Hong Kong, South China Sea. 21.55° S, 116.217° E, 183 m. Coll. USFC Steamer Albatross, 4 Nov 1908. 1 wet spec.  $R=1.1$ ,  $r=0.8$ .

### *Poraniomorpha* Danielssen and Koren 1881

*Poraniomorpha* Danielssen and Koren 1881: 189.—1884: 67–70.—Verrill 1895: 139.—Grieg 1907: 41–42.—Fisher 1911: 248 (in key).—1919: 407.—Koehler 1924: 157.—Mortensen 1927: 92.—Gallo 1937: 1664–1667.—Djakonov 1950: 58–59 (1968: 48–49).—Spencer and Wright 1966: U70.—Clark 1984: 33–41.—Clark and Downey 1992: 212.—Mah and Foltz 2014: 350.

*Rhegaster* Sladen 1883: 155.—1889: 367.—Bell 1893: 80.—Verrill 1914: 17.

*Lasiaster* Sladen, 1889: 371–372.—Bell 1893: 81.—Verrill 1899: 198.

**Diagnostic comments.** The diagnosis herein follows Mah and Foltz (2014), who recognised *Poraniomorpha* as a separate genus from *Culcitopsis*, disagreeing with Clark and Downey (1992), who argued that *Culcitopsis* was a subgenus of *Poraniomorpha*. This includes taxa with polygonal, imbricate, fenestrate plates and a solid abactinal skeleton as separate from species within *Culcitopsis*, which demonstrate strongly expressed fleshy tissue as part of their body wall.

**Diagnosis.** Body shape ranges from pentagonal to strongly stellate ( $R/r=1.2-2.75$ , 3.7–3.9 in this case), arms triangular, variably short to elongate. Characterised by compact, imbricate, fenestrate abactinal plates irregular in shape, but weakly convex, mound-like in overall appearance. Body surface overlaid by thick dermal tissue invested with granules bearing pointed tips, variable in abundance, density and homogeneity, covering abactinal marginal and actinal surface, obscuring plate boundaries. In other species, actinolateral fringe discrete with larger, thicker spines variably present. Actinal regions relatively large, plates imbricate in transverse series. Adambulacral armature prominent, forming a spiny fringe along tube foot groove. Two to five furrow spines.

**Comments.** Four species of *Poraniomorpha* are currently recognised: *P. abyssicola* (Verrill, 1895), *P. bidens* Mortensen 1932, *P. hispida* (Sars, 1872), and *P. tumida* (Stuxberg, 1878), all of which occur in the North Atlantic and adjacent waters. This is the first occurrence of *Poraniomorpha* in the Southern Hemisphere.

### *Poraniomorpha tartarus* n. sp.

Figure 3a–e.

**Etymology.** The species epithet is named for Tartarus, the mythical Greek underworld, alluding to this species' occurrence at great depth. Noun held in apposition.

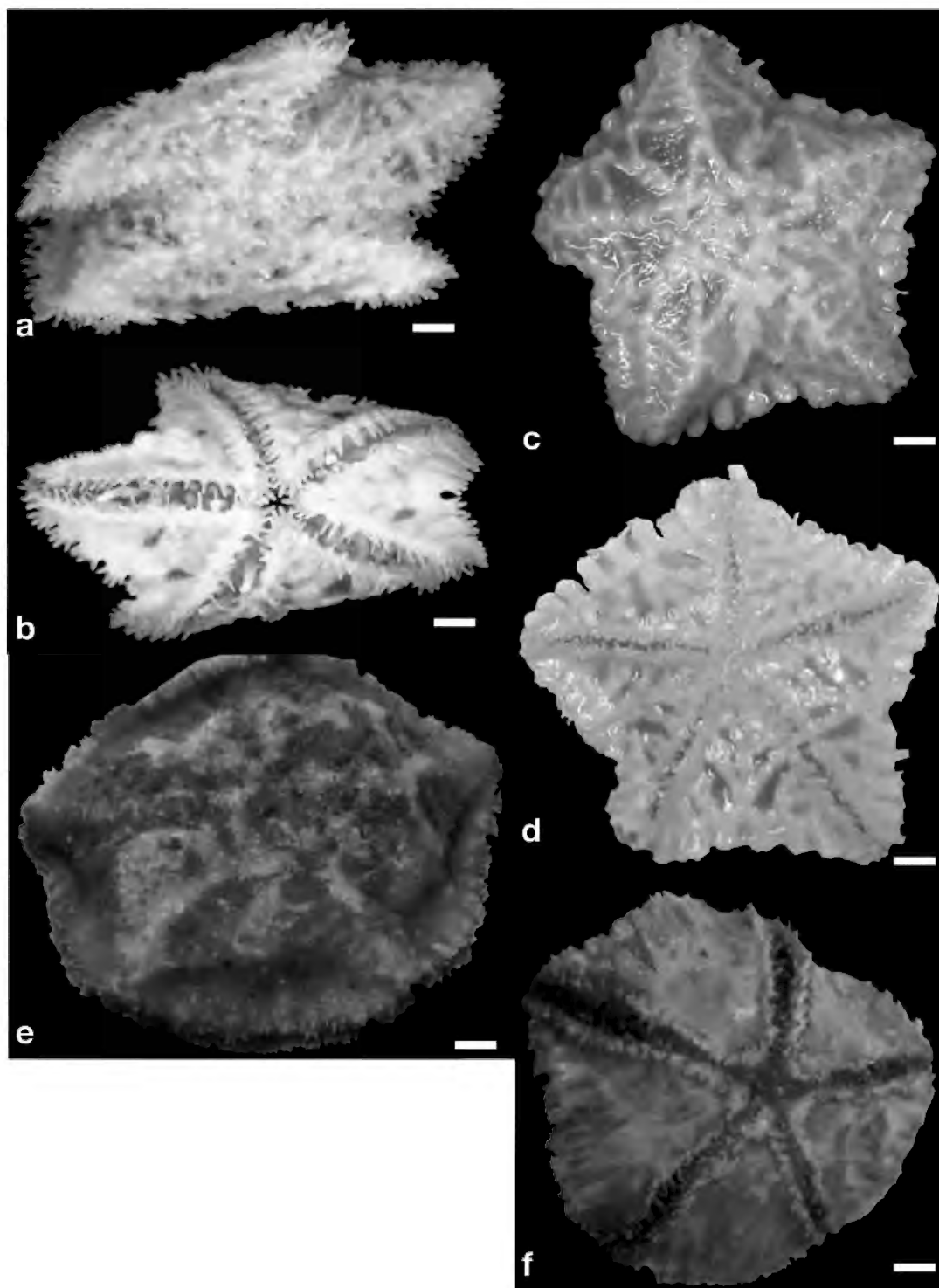


Figure 2. *Marginaster paucispinus* NMV F240386: a, abactinal view; b, actinal view; USNM holotype 032641: c, abactinal view; d, actinal view. MNHN-2013-1518: e, abactinal view; f, actinal view. Scale bars a, b=1.0 mm, c, d, e, f=1.5 mm. Photos by Melanie Mackenzie NMV.



**Diagnosis.** Body strongly stellate (Fig. 3a). Actinolateral fringe rounded with rounded edge (Fig. 3c, d). Abactinal surface hard, very resistant to the touch. Surface covered by minute, pointed granules embedded in dermal integument (Fig. 3b, d). Drying of specimen suggests flattened marginals are polygonal plates, approximately 48 per interradius. Actinal region narrow, surface is flat, with approximately 50 shallow segments corresponding with adambulacral and marginal plates but also bisecting the actinal intermediate region extending to the oral plate. Actinal surface also covered by small granules, covered by dermis, 5–30 per actinal segment, each with a hyaline tip invested in the dermal integument. Dark brown colour adjacent to the adambulacral spination on the disk and along the arms (Fig. 3c, d, e). One or two furrow spines, with 1–2 enlarged subambulacral spines, each approximately twice the thickness of and more elongate than the furrow spines (Fig. 3d, e).

**Comments.** Although *P. tartarus* n. sp. possesses a rounded actinolateral edge, unlike other *Poraniomorpha* species, several other characters – including irregular imbricate plates, the pointed granules invested in the dermal tissue, and the distinctively enlarged subambulacral and furrow spination on the adambulacral plates (Fig. 3d, e) – support placement within *Poraniomorpha*.

*Poraniomorpha tartarus* n. sp. invites comparison with Atlantic species such as *P. abyssicola* (Verrill, 1895) and *P. tumida* (Stuxberg, 1878), which it resembles very closely. They share similar abactinal plate morphology, displaying closely articulated irregular-shaped, imbricate, mound-like plates bearing a cover of spinose granules covering the surface such that plate boundaries are obscured. The disk in these species is strongly arched and arms are similarly elongate and tapering. Furrow spines are relatively few in both species (1–2 in *P. tartarus* n. sp. versus 2–3 in *P. abyssicola* but 3–5 in *P. tumida*). *Poraniomorpha tartarus* n. sp. is distinguished by the enlarged subambulacral spine, the absence of most papulae from the abactinal surface, and the difference in actinal plate texture, which possesses distinct transverse segments and lacks the numerous pointed spinelets seen in *P. abyssicola*. Neither *P. abyssicola* nor *P. tumida* are known to display the distinct colouration of *P. tartarus* n. sp.

*Poraniomorpha tartarus* n. sp. is the first known occurrence of this genus in the Southern Hemisphere and is also the deepest known species of the genus (3850–3853 m). *Poraniomorpha abyssicola* occurs at comparable depth in the Atlantic (2976–3740 m).

Although very little is known about the biology of *Poraniomorpha* spp., the NOAA vessel *Okeanos Explorer* observed *P. abyssicola* feeding on a sponge at 3403 m (Mah, 2020). *Poraniomorpha tartarus* n. sp. may feed on similar prey.

**Occurrence.** Known only off East Gippsland, Victoria, Tasman Sea, 3850–3853 m.

**Description.** Body strongly stellate ( $R/r=3.7\text{--}3.9$ ) (Fig. 3a, c) with elongate arms, round in cross-section. Disk and arms confluent, disk strongly convex, rms thick, tips strongly upturned. Interradial arcs acute. Actinolateral fringe rounded with no distinct edge.

Disk plates not evident, thick integument covers all of body surface (Fig. 3a, b). Body texture hard to touch. General surface topology rough, presenting a wrinkled appearance, covered by minute, pointed granules invested in dermal integument (Fig. 3b). Individual plates irregular in shape, surface texture mound-like. Granular cover is complete, evenly distributed, approximately 5–6 along a 1.0 mm line. Papulae mostly absent from abactinal surface with some occurring interradially (5–8 observed between arms in each interradius), with few present proximally on the lateral sides of each arm. Anus at center of disk, flanked by 8–10 angular granules around edge. Dermal granules around anus slightly larger than those elsewhere. Madreporite convex, outline circular, large, approximately 1.5 (smaller specimen) to 3.0 (larger specimen) cm in diameter (Fig. 3a, b). On the holotype, madreporite adjacent to contact with superomarginal plates. Basal portion of madreporite covered by small dermal granules. No pedicellariae observed. Interradii each with a discrete fold each bearing 10–15 slender grooves that synchronise with those on marginal to actinal plates. Shallow transverse fasciolar channels extend from abactinal surface along lateral surface aligned with those on actinal surface and adambulacral plates.

Marginal plates completely obscured by dermal integument. Drying shows marginal plates, flattened, polygonal, approximately 48 per interradius (armtip to armtip), boundaries are obscured, exact count uncertain. Single row of approximately 5–8 papulae, in mostly single pores, along lateral surface of arm.

Actinal surface flat with approximately 50 shallow transverse grooves tracking from marginal to adambulacral plates forming segments. These grooves bisecting the actinal intermediate region tracking from the oral plate (Fig. 3d, e). Actinal surface covered by small granules, 5–30 per actinal segment, covered by dermis, each with a hyaline tip invested in the dermal integument. A dark colour pattern, especially evident on NMV F241811 (Fig. 3c), present adjacent to the adambulacral spine series and around the mouth extending interradially on to the disk.

Furrow spines (1–2) large and prominent, covered by dermal integument, conical tip, blunt spines widely spaced interlacing with furrow spines on opposing side (Fig. 3b, d, e). Subambulacral spine mostly single, but two are present on approximately 40% of adambulacrals, especially on NMV F241811, approximately twice the thickness of each furrow spine arranged transversely relative to the furrow spine. Remaining adambulacral plates with single, short subambulacral spine, variably blunt and smooth, a minority of spines with notched or roughened tip. At least one of the larger subambulacral spines comparable in size with one of the furrow spines. Those secondary subambulacrals spines smaller, less than half the height and thickness of the furrow spine. Dermal integument covers the adambulacral plate; no other accessories are present.

Oral plates with four furrow spines and one spine from each oral plate projecting into the mouth (two total). Oral plate surface, with a total of 4–6 suboral spines (two or three per half).

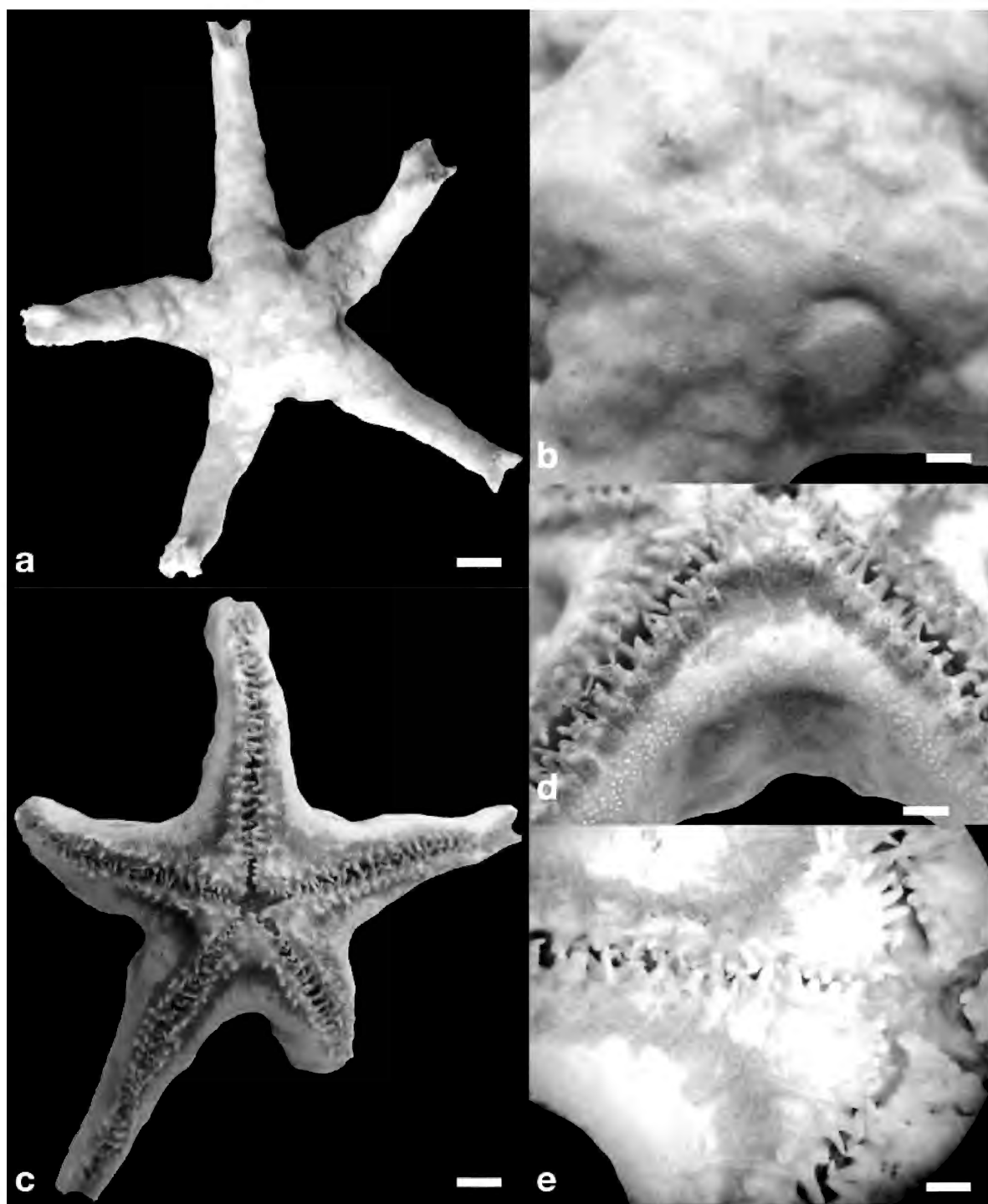


Figure 3. *Poraniomorpha tartarus* n. sp., holotype. NMV F 241811: a, abactinal; b, abactinal surface showing madreporite, surface texture; c, actinal view; d, actinal intermediate region and inferomarginals; e, actinal view furrow spines, oral region. Scale bars a=9.0 mm, b=5.0 mm, c=9.0 mm, d, e=2.0 mm.

Colour in life white to dark brown on disk, arms mottled, dark brown to white, interradii dark brown. Underside is white with dark brown in each interradius around mouth (Fig. 3c, d, e). Dark colouration present in patches along adambulacral series.

**Material examined.** Holotype. NMV F 241811 East Gippsland, Victoria, Tasman Sea, Australia, -38.479° S, 150.185° E, 3850–3853 m, Coll. O'Hara et al. aboard RV *Investigator* 24 May 2017, 1 wet spec. R=5.4, r=1.3.

Paratype. NMV F 241807 East Gippsland, Victoria, Tasman Sea, Australia, -38.479° S, 150.185° E, 3850–3853 m, Coll. O'Hara et al. aboard RV *Investigator* 24 May 2017, 1 wet spec. R=5.7, r=1.3.

#### Discussion. Deep-Sea Australian Asteroidea

To date, based on Rowe and Gates (1995), the observations of *P. tartarus* n. sp. at 3850–3853 m are the deepest known for an Australian asteroid, and comparable to the similar northern hemisphere *P. abyssicola* found at 2976–3740 m (Mah and Foltz, 2014).

The most recent taxonomic catalog of Australian asteroid species (Rowe and Gates, 1995) summarised several deep-sea groups, which are known for having widely and deeply occurring species, including the Porcellanasteridae, Benthoplectinidae, Caymanostellidae and the Zoroasteridae. However, many of these groups were represented by relatively shallow members (e.g. *Pholidaster* in the Zoroasteridae, 28–243 m), and many of these families have yet to be recorded from lower bathyal to abyssal Australian settings (1000–6000 m). For example, their account lists the porcellanasterid *Porcellanaster ceruleus*, with a depth range of 1160–6040 m; this is the global range, as indicated in Clark and Downey (1992), rather than Australian occurrence. Survey reports, such as those by O'Hara et al. (2020) and MacIntosh et al. (2018), present preliminary occurrence data from these depths (e.g. 200–5000 m) but detailed accounts of species from these expeditions await preparation.

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## New species of *Travisia* Johnston, 1840 (Annelida, Traviidae Hartmann-Schröder, 1971) from south-eastern Australia

(<https://zoobank.org/References/EFED810A-E671-400D-BFD6-A8DBA0C42D89>)

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### Abstract

Avery L., Vodopyanov S. & Wilson R.S. 2023. New species of *Travisia* Johnston, 1840 (Annelida, Traviidae Hartmann-Schröder, 1971) from south-eastern Australia. *Memoirs of Museum Victoria* 82: 133–142.

Two new species of *Travisia* Johnston, 1840 (Annelida, Traviidae) are described from the continental shelf of south-eastern Australia: *Travisia tribus* sp. nov. and *Travisia una* sp. nov. *Travisia olens novaezealandiae* Benham, 1927 is raised to species rank as *Travisia novaezealandiae* Benham, 1927 new status. We describe epidermal structures using scanning electron microscopy, and discuss pygidial morphology of the two new *Travisia* species and distinguish an additional character. We recognise four species of *Travisia* recorded from Australia and include a dichotomous key to allow their identification. A separate downloadable resource provides access to an annotated morphological character list for *Travisia* species, a downloadable interactive key using the Delta (Descriptive Language for Taxonomy) Intkey software, and concise descriptions and minimal diagnoses and descriptions of all currently recognised species of *Travisia*.

### Keywords

Scalibregmatidae, interactive key, benthic, polychaetes, diagnosis, DELTA, Intkey

### Introduction

*Travisia* Johnston, 1840 is a genus of marine annelids with short, stout bodies that taper abruptly to anterior and posterior ends; most have fewer than 50 segments. Species of *Travisia* are easily recognised by their distinctive tapering slug-like body, pale body and unpleasant odour when alive. They are recorded from soft sediments in locations worldwide and from the intertidal to depths of 8,300 m (Read and Fauchald, 2023).

*Travisia* is assigned to the family Traviidae Hartmann-Schröder, 1971 in most recent treatments (Blake and Maciolek, 2016; Rizzo and Salazar-Vallejo, 2020; Yang et al., 2022; Read and Fauchald, 2023). Recent molecular studies show *Travisia* to be sister group to Scalibregmatidae Malmgren, 1867 (Persson and Pleijel, 2005; Paul et al., 2010; Law et al., 2014; Rouse et al., 2022). However, in the absence of a phylogenetic analysis with more complete sampling of all 16 scalibregmatid genera, it remains unclear whether *Travisia* would be sister group to all other Scalibregmatidae and in which family the genus might

ultimately be placed. In this study, we therefore retain *Travisia* in the family Traviidae.

*Travisia* currently includes 38 described species, excluding the two new species described below (Read and Fauchald, 2023). Rizzo et al. (2020) include a key to all species of *Travisia* described to that time. We recognise four species of *Travisia* from Australian waters: *T. lithophila* Kinberg, 1866 (from New South Wales), *T. oksae* Hartmann-Schröder and Parker, 1995 (from South Australia and Victoria), plus the two new species from south-eastern Australia described below: *T. tribus* sp. nov. and *T. una* sp. nov. All four species are known only from Australia.

Two additional *Travisia* species are also nominally recorded from Australia, but we do not accept these records. *Travisia forbesii* Johnston, 1840 was recorded from Port Phillip Bay, Victoria, by Poore et al. (1975) but this material was referred to *T. oksae* by Hartmann-Schröder and Parker (1995). A further report of *T. forbesii* from Australia in the Australian Faunal

Directory (Hutchings et al., 2013) attributed to Augener (1922) is probably an error based on the Poore et al. (1975) record; no *Travisia* species is treated in Augener (1922).

A single record of *Travisia olens* Ehlers, 1897 (type locality Strait of Magellan) from north-western Western Australia is based on a single 27 chaetiger, 12 mm long specimen described by Hartmann-Schröder (1980: 74). This description lacks sufficient detail, for example regarding pygidial lobes, to distinguish from about 12 other *Travisia* species with triannulate anterior chaetigers and biannulate mid- to posterior chaetigers. The Australian record should be instead considered *Travisia* cf. *olens*-Hartmann-Schröder (1980). *Travisia olens* Ehlers, 1897 is not recorded from Australia. A key to the four Australian species of *Travisia* is included below.

## Methods

Descriptions and comparisons with other taxa used the Delta (Descriptive Language for Taxonomy) suite of programs (Dallwitz and Paine, 2015), now available as a revised version, Open-Delta, implemented in Java; this version runs on all popular operating systems – Windows, Mac, Linux (Atlas of Living Australia, 2014). Another implementation, Free Delta (Cavalcanti, 2022) supports some different editing functionality and other features including outputs in .csv format but lacks an implementation of interactive identification equivalent to Intkey. All three implementations of Delta (Atlas of Living Australia, 2014; Dallwitz, 2020; Cavalcanti, 2022) read data files in the same format; we used Open-Delta, but most functions are compatible across all implementations, and below we refer to the system simply as Delta.

Delta is a suite of software based on a database (conceptually, a matrix of characters by taxa), enabling consistent, efficient descriptions of taxa using a standardised character set. Components of the software generate outputs including natural language descriptions, diagnoses (discussed further below), linear keys and interactive keys (Dallwitz, 1980).

*Travisia* species are described and distinguished using a relatively restricted set of characters (Blake and Maciolek, 2016; Rizzo and Salazar-Vallejo, 2020) and can be readily studied using the Delta system. A Delta interactive key enabling identification of all species of *Travisia* is available for download (Wilson and Avery, 2023); use of the key requires installation of either version of the Intkey software, although we recommend the 2014 Java version (Atlas of Living Australia, 2014). An introduction to the use of either version of Intkey is provided by Coleman et al. (2010). In addition to the Delta Intkey files, Wilson and Avery (2023) allows download of the descriptions and diagnoses of all 40 recognised species of *Travisia* and an annotated list of characters (as text documents).

For the *Travisia* species in this study and in Wilson and Avery (2023), we include both a description and a diagnosis for each species. Our descriptions are Delta-generated natural language outputs, with additional detail in the case of the new species described below. Diagnoses should be minimal statements that precisely distinguish taxa (Borkent, 2021); ours are generated using the Delta system with settings (DiagLevel=2)

that specify the minimum number of characters needed to distinguish a taxon from all other included taxa.

Light photography was performed using a Leica® M125 stereo microscope and Flexcam C3 (Leica Microsystems). Scanning electron micrographs were taken with an FEI Inspect® F50 scanning electron microscope (SEM), otherwise SEM methods are as described in Vodopyanov et al. (2014). Measurements of epidermal papillae were taken from SEMs, averaged from 10 papillae per specimen, one specimen per species. Two measurements of each papilla were taken: the maximum length (along the length axis of the worm, dimension x in figs 7 and 15) and maximum width (around the circumference of the worm, dimension y in figs 7 and 15).

Specimens were collected during several benthic surveys of Bass Strait in south-eastern Australia (Coleman et al., 1997, 2007), from Western Port, an adjacent coastal bay (Poore, 1986) and from several smaller benthic surveys in South Australia and Tasmania (specimens now deposited in Museums Victoria). All specimens were formalin-fixed when collected, thus molecular data were not available. Specimens are deposited in the collections of Museums Victoria, Melbourne, Australia (previously National Museum of Victoria – NMV), the Australian Museum, Sydney, Australia (AM), the South Australian Museum, Adelaide, Australia (SAM) and the Natural History Museum, London, United Kingdom (NHMUK). Specimen data are provided in “material examined” lists below and the Atlas of Living Australia (2023).

## Morphological characters for *Travisia*

Terminology for characters follows Blake and Maciolek (2016), with some minor modifications aimed at practical separation of alternative conditions (character states). Many of the characters currently used to describe and discriminate species of *Travisia* potentially vary with size of worm. Investigation of this issue is beyond the scope of this study but remains a concern, especially as only 13 of the 38 species of *Travisia* are based on descriptions of more than six specimens, and 17 species descriptions are based on one or two specimens (based on published data in original descriptions). Yang et al. (2022) do show that numbers of chaetigers and branchiae and position of first parapodial lobes do not vary with length for *T. amoyanus* Yang, Wu, Wang, Zhao, Hwang and Cai, 2022, but size-related variation of other characters and in other species remains poorly understood.

Coding of morphological characters in this study follows recent literature (Blake and Maciolek, 2016; Yang et al., 2022 Table S5) except where noted below. Our complete list of characters and states is available from Wilson and Avery (2023).

**Prostomium form.** In most *Travisia* species the prostomium is conical and pointed, but in some it may be anteriorly truncate or rounded. Blake and Maciolek (2016) distinguish four prostomial forms (rounded, conical, pointed, or truncate) but many pointed prostomia are also conical so we distinguish three states: pointed (more or less conical); truncate; rounded.

**Prostomium proportions.** Proportions of the prostomium are given as either shorter than maximum width; about as long as maximum width; longer than maximum width. Distortion of

prostomium during preservation means that not all specimens can be scored for this character, which is not provided in many published descriptions.

**Mouth location.** The mouth emerges ventrally, the upper lip formed by extension of the annulation on chaetiger 1, and the lower lip is formed similarly from chaetiger 2 (Blake and Maciolek, 2016). However, these ventral extensions are apparently transformed so that in some species the mouth is positioned on chaetiger 1 or 2, instead of the more common location on the border between chaetigers 1 and 2.

**Peristomium.** The achaetous ring posterior to the prostomium is termed the peristomium by Blake and Maciolek (2016) but some authors refer to it as segment 1 or the anterior achaetous segment. The peristomium is apparently undivided in all *Travisia* species, although for some this information is not available from published descriptions.

**Epidermal papillae.** The structure of papillae and other epidermal ornamentation varies considerably between species of *Travisia*. For example, papillae may cover the body in regular rows or in irregular patterns, they may be small or large, in which case papillae are often described as pustules. Papillae are sometimes described as absent (“epidermis smooth”), but this probably reflects superficial observations. Elsewhere, the fine structure of epidermal papillae in *T. forbesii* has been compared with other annelids and was found to be different from those of all other annelid families studied so far (Vodopyanov et al., 2014). Studies of the fine structure of epidermal papillae are yet to be made in other *Travisia* species, therefore it is unknown whether these structures will provide synapomorphies for the genus *Travisia* or assist with discrimination of species within the genus. In this study we employed SEM to investigate the fine structure of epidermal papillae for the two new species described here. As described in the Methods, above, we provide mean values of two dimensions, length and width, for 10 papillae per species, for evaluating possible taxonomic value in comparisons with other *Travisia* species.

**Pre-pygidial segment ornamentation.** In addition to the crenellations seen, for example, in *T. kerguelensis* McIntosh, 1885, pre-pygidial segments may be ornamented with one or more circlets of papillae forming a complete ring around the segment. States observed thus far in *Travisia* are: without circlet of papillae (e.g. *T. lithophila* Kinberg, 1866); with a single ring of papillae encircling last segment (e.g. *T. japonica* Fujiwara, 1933) or with the last four segments each encircled with a ring of papillae (e.g. *T. doellojuradoi* Rioja, 1944).

**Number of pygidial lobes.** In most *Travisia* species the pygidium is a ring divided into a number of lobes, which we refer to as anal lobes. These are the same as the “pygidial papillae” of some authors, but using the term lobes helps to distinguish smaller papilla-like structures that we term terminal anal cirri, here treated as a separate character (see below). The pygidial lobes are digitiform and usually barely longer than wide, but wider and narrower lobes may also be present, sometimes on a single specimen. Pygidial lobes typically range in number from five to about 15 (exceptionally up to 22, in *T. una* sp. nov.).

**Terminal anal papillae.** Pygidial lobes may have much narrower terminal extensions. These we refer to as terminal anal papillae (the “subterminal papillae” of Elias and Bremec (2003) which is a misnomer, since they are clearly terminal). Other authors have used a range of other terms. Terminal anal papillae, if present, may number from one to seven.

**Internal pygidial cirri.** Within the ring of pygidial lobes there may also be a second ring of smaller cirriform structures. These have apparently not been distinguished from pygidial lobes by earlier researchers; we refer to them as internal pygidial cirri. It is not clear if the internal rings of internal pygidial cirri are really distinct from the (outer ring of) pygidial lobes. Internal pygidial cirri are often partly hidden within the ring of pygidial lobes and are difficult to count; if present (or observable – they are perhaps fragile or retractile or both), they apparently number from one to ten, but due to the variable visibility of these structures, values from the literature are probably not reliable and this character probably occurs more widely than we are aware. For this study, we have documented the presence of internal pygidial cirri in four species: *T. amoyanus* Yang, Wu, Wang, Zhao, Hwang and Cai, 2022, *T. araciae* Rizzo and Salazar Vallejo, 2020, *T. glandulosa* McIntosh, 1879 and *T. tribus* sp. nov.

**Staining pattern.** Patterns due to selective take-up of stain by epidermal tissue have been used to seek additional features for discriminating *Travisia* species, including shirlastain (Vodopyanov et al., 2014; Wiklund et al., 2019) and methyl green (Maciolek and Blake, 2006; Kobayashi and Kojima, 2021). Schiaparelli and Jirkov (2021) found methylene blue (already in use in our laboratory) to be more effective than methyl green, and we report methylene blue staining pattern here.

## Systematic account

### Family Traviidae Hartmann-Schröder, 1971

#### Genus *Travisia* Johnston, 1840

**Description.** Body stout, pointed at both ends, fusiform, or grub-like, with or without lateral or ventral grooves. Peristomium not annulated. Subsequent segments annulated, with posterior segments forming folds ending in dorsal lappets. Epidermis papillated. Prostomium small, smooth, rounded, conical or truncate, without eyes; nuchal organs present. First chaetiger anterior to mouth. Parapodia reduced, small, smooth, or entirely absent. Branchiae usually present, rarely absent or unobservable, when present from chaetigers 2 or 3, cirriform or branched, sometimes annulated. Interramal pores present; lateral eyes absent. Chaetae simple capillaries, sometimes hispid. Pygidium small, cylindrical, longitudinally furrowed, with ring of stout equal or unequal pygidial lobes, with or without terminal anal papillae and internal pygidial cirri.

**Type species.** *Travisia forbesii* Johnston, 1840.

**Remarks.** The description above follows Rizzo and Salazar-Vallejo (2020), with terminology slightly modified in accordance with the above character list and addition of statement that the peristomium is not annulated.



***Travisia novaezealandiae* Benham, 1927 new status**

*Material examined.* New Zealand "North coast ... stomach of Schnapper", NHMUK 1928.2.29.53 holotype Terra Nova Expedition.

*Diagnosis.* Body comprising 37–39 chaetigers; annulation pattern changes at chaetigers 14–15; posterior-most segments crenellated; branchiae present on 35–38 chaetigers.

*Description.* Body comprising 38–40 segments; 37–39 chaetigers; 0–2 achaetous posterior segment(s) (cannot determine exactly, but no more than two achaetous posterior segments).

Prostomium shorter than maximum width. Mid-ventral groove absent. Mouth located on chaetiger 1.

Chaetiger 1 biannulate; 2 triannulate; subsequent anterior chaetigers triannulate; annulation pattern changes at chaetigers 14–15; posterior chaetigers biannulate (annulations much more obvious than on anterior segments).

Branchiae about as long as diameter of body. Branchiae first present on chaetiger 2; present on 35–38 chaetigers (apparently, although many posterior branchiae are lost/damaged – the number of posterior abbranchiate segments is in the range 0–2).

Parapodial lobes present; notopodial lobes commence chaetiger 6; neuropodial lobes commence chaetiger 3. Nephridiopores first present chaetiger 3; last present chaetiger 14. Posterior-most segments crenellated.

Pygidial lobes at least 6, the holotype is too damaged to determine exact number of lobes.

*Remarks.* *Travisia olens novaezealandiae* Benham, 1927 (type locality north coast of New Zealand) is here raised to species status on the basis of the following differences from *T. olens* Ehlers, 1897 (type locality Strait of Magellan): in *T. novaezealandiae* the annulation pattern changes at chaetigers 14–15 (at about chaetiger 20 in *T. olens*); in *T. novaezealandiae* the pre-pygidial segments lack a circle of papillae (in *T. olens* a single ring of papillae encircles the last segment); *T. novaezealandiae* has at least six pygidial lobes (12–15 in *T. olens*). There are other apparent differences, for example, in the chaetigers on which branchiae and parapodial lobes occur, but these may be subject to observational errors, especially of *T. olens novaezealandiae* Benham, 1927, the holotype of which was collected from a fish gut and is damaged.

***Travisia tribus* sp. nov.**

<https://zoobank.org/urn:lsid:zoobank.org:act:5CC5BBDC-CF22-4D80-9ED3-ED16F1DDC17B>

Figures 1–7

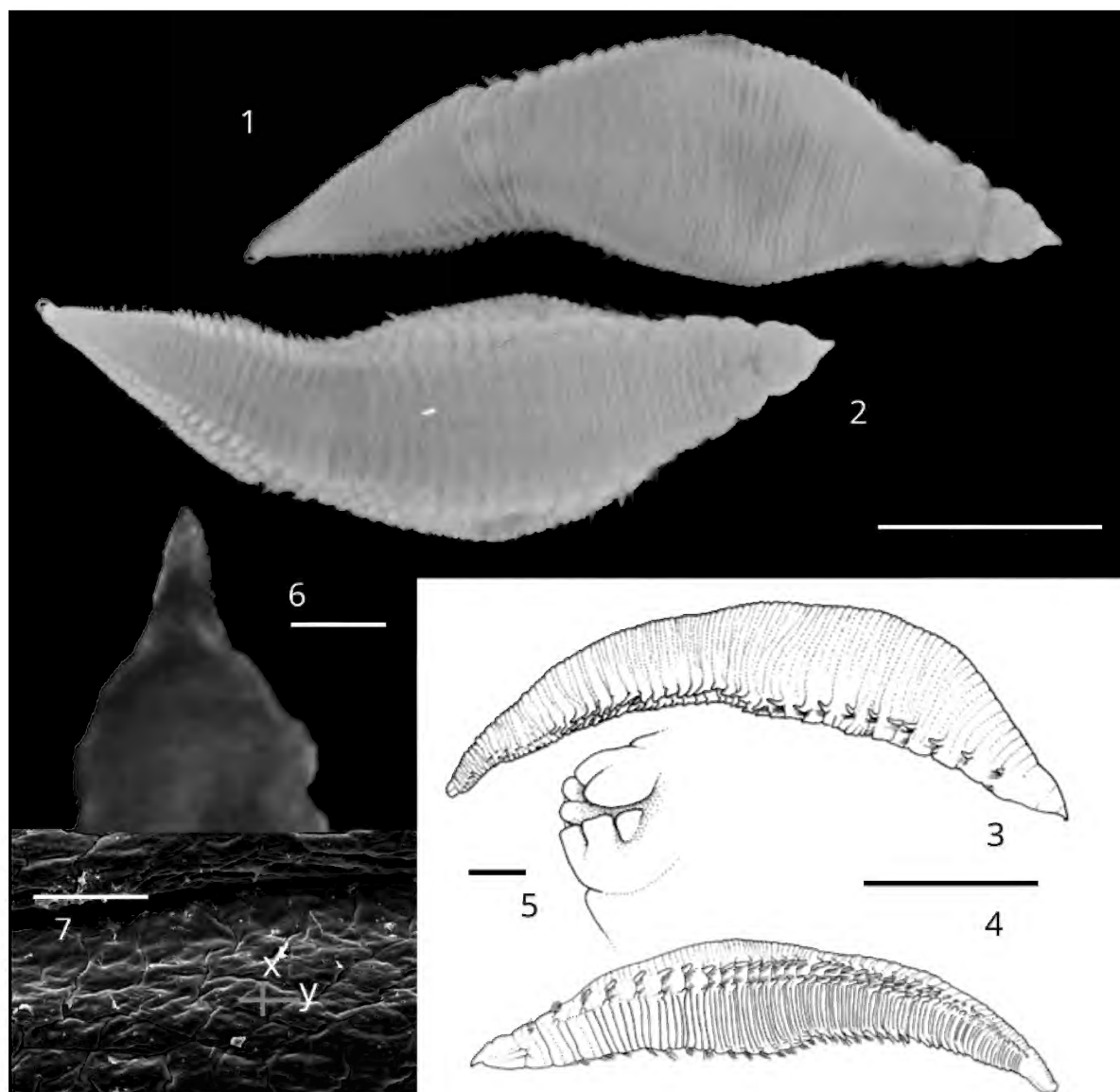
*Material examined.* Holotype: Australia, Victoria: Bass Strait, 1 km off Delray Beach, Stn MSL-LV 6 T8, 38° 14' S 147° 22' E, 29 Aug 1990, 15.4 m, NMV F64973.

Paratypes: Australia. Bass Strait, 1 km off Delray Beach, Stn MSL-LV 5 D8, 38° 14' S 147° 22' E, 29 Aug 1990, 16.5 m, 1, NMV F64952; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 6 T3, 38° 14' S 147° 22' E, 29 Aug 1990, 14.8 m, 1, NMV F64961; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 1 T6, 38° 14' S 147° 22' E, 1 Mar 1989, 15 m, 1, NMV F64967; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 5 W5, 38° 33' S 146° 57' E, 25 Aug 1990, 14.5 m, 1, NMV F64920; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 1 T2, 38° 14' S 147° 22' E, 1 Mar 1989, 16.5 m, 1, AM W54586.

Non-type material: Australia. Victoria: Bass Strait, 1 km off Delray Beach, Stn MSL-LV 5 D8, 38° 14' S, 147° 22' E, Jan 1990, 16.5 m, 3, NMV F271084-271086; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 1 D1, 38° 14' S, 147° 22' E, 24 Jan 1989, 16.1 m, 1, NMV F64930; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 1 D4, 38° 14' S, 147° 22' E, Jan 1989, 16 m, 1, NMV F64940; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 1 D6, 38° 14' S, 147° 22' E, Jan 1989, 15.8 m, 1, NMV F64946; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 1 T8, 38° 14' S, 147° 22' E, Jan 1989, 15.4 m, 1, NMV F64971; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 2 D3, 38° 14' S, 147° 22' E, Jan 1989, 16 m, 1, NMV F64935; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 2 T7, 38° 14' S, 147° 22' E, Jan 1989, 14.8 m, 4, NMV F64968; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 3 D2, 38° 14' S, 147° 22' E, Jan 1989, 16 m, 1, NMV F64931; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 3 D3, 38° 14' S, 147° 22' E, Jan 1989, 16 m, 2, NMV F64936; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 3 D4, 38° 14' S, 147° 22' E, Jan 1989, 16 m, 1, NMV F64941; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 3 D5, 38° 14' S, 147° 22' E, 17 Jan 1989, 16 m, 6, NMV F64944; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 3 D6, 38° 14' S, 147° 22' E, Jan 1989, 15.8 m, 1, NMV F64947; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 3 D8, 38° 14' S, 147° 22' E, Jan 1989, 16.5 m, 2, NMV F64951; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 3 T1, 38° 14' S, 147° 22' E, Jan 1989, 16.6 m, 4, NMV F64954; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 3 T3, 38° 14' S, 147° 22' E, 24 Jan 1989, 14.8 m, 1, NMV F64958; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 3 T4, 38° 14' S, 147° 22' E, Jan 1989, 14.8 m, 1, NMV F64962; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 3 T5, 38° 14' S, 147° 22' E, Jan 1989, 15 m, 1, NMV F64964; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 D2, 38° 14' S, 147° 22' E, 17 Jan 1989, 16 m, 2, NMV F64932; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 D3, 38° 14' S, 147° 22' E, 17 Jan 1989, 16 m, 9, NMV F64937; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 D4, 38° 14' S, 147° 22' E, Jan 1989, 16 m, 1, NMV F64942; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 D5, 38° 14' S, 147° 22' E, 17 Jan 1989, 16 m, 11, NMV F64945; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 D6, 38° 14' S, 147° 22' E, 17 Jan 1989, 15.8 m, 1, NMV F64948; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 D7, 38° 14' S, 147° 22' E, 11 Jan 1989, 15.5 m, 1, NMV F64949; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 T1, 38° 14' S, 147° 22' E, 24 Jan 1989, 16.6 m, 8, NMV F64955; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 T2, 38° 14' S, 147° 22' E, 24 Jan 1989, 16.5 m, 1, NMV F64957; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 T3, 38° 14' S, 147° 22' E, Jan 1989, 14.8 m, 1, NMV F64959; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 T4, 38° 14' S, 147° 22' E, Jan 1989, 14.8 m, 2, NMV F64963; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 T5, 38° 14' S, 147° 22' E, Jan 1989, 15 m, 2, NMV F64965; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 T7, 38° 14' S, 147° 22' E, Jan 1989, 14.8 m, 1, NMV F64969; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 4 T8, 38° 14' S, 147° 22' E, Jan 1989, 15.4 m, 2, NMV F64972; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 5 D2, 38° 14' S, 147° 22' E, 29 Jan 1990, 16 m, 1, NMV F64933; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 5 D3, 38° 14' S, 147° 22' E, Jan 1990, 16 m, 1, NMV F64938; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 5 D7, 38° 14' S, 147° 22' E, Jan 1990, 15.5 m, 3, NMV F64950; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 5 T3, 38° 14' S, 147° 22' E, Jan 1990, 14.8 m, 3, NMV F64960; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 6 D2, 38° 14' S, 147° 22' E, 29 Jan 1990, 16 m, 1, NMV F64934; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 6 D3, 38° 14' S, 147° 22' E, 29 Jan 1990, 16 m, 1, NMV F64939; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 6 D4, 38° 14' S, 147° 22' E, Jan 1990, 16 m, 1, NMV F64943; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 6 D8, 38° 14' S, 147° 22' E, 29 Jan 1990, 16.5 m, 3, NMV F64953; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 6 T5,

38° 14' S, 147° 22' E, Jan 1990, 15 m, 1, NMV F64966; Bass Strait, 1 km off Delray Beach, Stn MSL-LV 6 T7, 38° 14' S, 147° 22' E, Jan 1990, 14.8 m, 1, NMV F64970; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 2 W7, 38° 33' S, 146° 57' E, Jan 1989, 15.1 m, 2, NMV F64923; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 3 W1, 38° 33' S, 146° 57' E, Jan 1989, 15.1 m, 2, NMV F64910; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 3 W2, 38° 33' S, 146° 57' E, Jan 1989,

15 m, 2, NMV F64913; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 3 W3, 38° 33' S, 146° 57' E, Jan 1989, 14.3 m, 2, NMV F64916; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 3 W4, 38° 33' S, 146° 57' E, Jan 1989, 15 m, 3, NMV F64918; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 3 W7, 38° 33' S, 146° 57' E, Jan 1989, 15.1 m, 7, NMV F64924; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 4 W3, 38° 33' S, 146° 57' E, Jan 1989, 14.3 m, 2, NMV F64917;



Figures 1–7. *Travisia tribus* sp. nov. 1 – dorsal view preserved specimen NMV F64920 (paratype); 2 – ventral view preserved specimen NMV F64920; 3 – lateral view NMV F64973 (holotype); 4 – ventral view NMV F64973 (holotype); 5 – pygidium detail NMV F64973 (holotype); 6 – methylene blue staining pattern prostomium ventral view NMV F64952 (paratype); 7 – SEM epidermal papillae from dorsum chaetiger 6 NMV F64920 (paratype). Image credits 1, 2, 6 Robin Wilson; 3–5 Kate Nolan; 7 Stepan Vodopyanov. Scale bar figs 1–4: 5 mm; 5: 0.2 mm; 6: 0.2 mm; 7: 50 µm; papilla measurements: x – dimension on papilla oriented with length of worm, y – dimension on papilla oriented with circumference of worm.

Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 4 W7, 38° 33' S, 146° 57' E, Jan 1989, 15.1 m, 4, NMV F64925; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 4 W8, 38° 33' S, 146° 57' E, Jan 1989, 15 m, 1, NMV F64927; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 5 W1, 38° 33' S, 146° 57' E, Jan 1990, 15.1 m, 3, NMV F64911; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 5 W2, 38° 33' S, 146° 57' E, Jan 1990, 15 m, 1, NMV F64914; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 5 W4, 38° 33' S, 146° 57' E, Jan 1990, 15 m, 1, NMV F64919; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 5 W6, 38° 33' S, 146° 57' E, Jan 1990, 15.5 m, 4, NMV F64921; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 5 W7, 38° 33' S, 146° 57' E, Jan 1990, 15.1 m, 1, NMV F64926; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 5 W8, 38° 33' S, 146° 57' E, Jan 1990, 15 m, 4, NMV F64928; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 6 W1, 38° 33' S, 146° 57' E, Jan 1990, 15.1 m, 7, NMV F64912; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 6 W2, 38° 33' S, 146° 57' E, Jan 1990, 15 m, 1, NMV F64915; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 6 W6, 38° 33' S, 146° 57' E, Jan 1990, 15.5 m, 1, NMV F64922; Bass Strait, 1 km off Woodside Beach, Stn MSL-LV 6 W8, 38° 33' S, 146° 57' E, Jan 1990, 15 m, 1, NMV F64929; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 1 S2, 38° 22' S, 147° 12' E, 9 Jan 1989, 16 m, 2, NMV F64892; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 2 S1, 38° 22' S, 147° 12' E, 9 Jan 1989, 15.5 m, 1, NMV F64889; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 2 S2, 38° 22' S, 147° 12' E, 9 Jan 1989, 16 m, 1, NMV F64893; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 2 S3, 38° 22' S, 147° 12' E, Jan 1989, 16 m, 1, NMV F64895; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 2 S6, 38° 22' S, 147° 12' E, 9 Jan 1989, 16 m, 1, NMV F64902; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 2 S7, 38° 22' S, 147° 12' E, Jan 1989, 16 m, 2, NMV F64905; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 3 S1, 38° 22' S, 147° 12' E, 23 Jan 1989, 15.5 m, 1, NMV F64890; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 3 S2, 38° 22' S, 147° 12' E, Jan 1989, 16 m, 1, NMV F64894; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 3 S3, 38° 22' S, 147° 12' E, Jan 1989, 16 m, 1, NMV F64896; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 3 S4, 38° 22' S, 147° 12' E, Jan 1989, 14.5 m, 2, NMV F64897; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 3 S5, 38° 22' S, 147° 12' E, Jan 1989, 15.5 m, 1, NMV F64899; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 3 S8, 38° 22' S, 147° 12' E, Jan 1989, 15.3 m, 1, NMV F64908; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 4 S1, 38° 22' S, 147° 12' E, 23 Jan 1989, 15.5 m, 3, NMV F64891; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 4 S4, 38° 22' S, 147° 12' E, Jan 1989, 14.5 m, 1, NMV F64898; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 4 S5, 38° 22' S, 147° 12' E, 23 Jan 1989, 15.5 m, 1, NMV F64900; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 4 S7, 38° 22' S, 147° 12' E, Jan 1989, 16 m, 1, NMV F64906; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 5 S5, 38° 22' S, 147° 12' E, 28 Jan 1990, 15.5 m, 1, NMV F64901; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 5 S6, 38° 22' S, 147° 12' E, 28 Jan 1990, 16 m, 1, NMV F64903; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 5 S7, 38° 22' S, 147° 12' E, 28 Jan 1990, 16 m, 2, NMV F64907; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 5 S8, 38° 22' S, 147° 12' E, 28 Jan 1990, 15.3 m, 3, NMV F64909; Bass Strait, near Seaspray, 1 km off The Honeysuckles, Stn MSL-LV 6 S6, 38° 22' S, 147° 12' E, 28 Jan 1990, 16 m, 1, NMV F64904.

South Australia: Great Australian Bight, Stn SS2013\_RC07 13, 33° 20.316' S, 130° 15.72' E, 13 Jan 2013, 200 m, 1, SAM; Great Australian Bight, SZ12, Stn IN2017\_C01 216, 35° 40.504' S, 135° 38.964' E, 25 Jan 2017, 141 m, 2, NMV F2425602.

Tasmania: off Bicheno, 41° 50.23' S, 148° 16.52' E, Apr 2020, 50 m, 1, NMV F305298.

**Diagnosis.** Body comprising 26–54 chaetigers, mouth located between chaetigers 1 and 2; branchiae present on 37–38 chaetigers; chaetiger 1 biannulate; chaetiger 2 triannulate; 6–8 posterior abbranchiate segments.

**Description.** Body comprising 26–62 segments; 26–59 chaetigers; 0–3 achaetous posterior segments; 9–90 mm long, 2–5 mm wide (holotype 21 mm long, 4 mm wide, 45 chaetigers plus three posterior achaetigerous segments). Fusiform, yellowish in alcohol [figs 1, 2]). Prostomium length about equal to maximum width; a pointed cone, often retracted or distorted in preservation. Mid-ventral groove absent (fig. 3). Mouth located between chaetigers 1 and 2. Chaetiger 1 biannulate, subsequent chaetigers until chaetigers 25–28 triannulate, transition to biannulate posterior chaetigers occurs incompletely over chaetigers 25–28 (24–25 in the holotype) (figs 1–4). Segments minutely papillate with raised ridge of slightly larger papillae on posterior-most part of each annulus. Branchiae present from chaetiger 2, 37–54 pairs (39 in the holotype), 6–9 posterior abbranchiate segments (nine in the holotype), branchiae initially short, becoming longer by chaetiger 8 but always much shorter than body diameter, most smooth several branchiae minutely annulate on mid-body chaetigers. Neuropodial and notopodial lappets present from chaetiger 1, initially minute flattened lobes, becoming progressively larger triangular finely papillate lappets from chaetiger 14–16 (15 in the holotype), neuropodial lobes commence chaetiger 12–14 (14 in the holotype) developed into prominent lappets enclosing deep lateral grooves over 10–15 posterior-most segments (12 in the holotype). Interramal pores first present chaetiger 1; last present chaetiger 26–40. Nephridiopores first present chaetiger 3 (but not visible on many specimens). Capillary chaetae smooth. Anal tube equal to length of two posterior segments. Pygidial lobes 5–7 (five in the holotype). Two or three internal pygidial cirri (two in the holotype) (fig. 5).

Epidermal papillae comprising irregular, barely raised polygons, each with 15–25 pores. Papillae width (~30 µm) about two times length (~15 µm) (width measured in circumferential direction around the worm, dimension y in fig. 7, length along the worm, dimension x in fig. 7). Prostomium mid-section darkly stained with methylene blue, tip and basal region unstained (fig. 6). Remainder of body uniformly stained, fading to only posterior-most annulation stained.

**Etymology.** The species name of *T. tribus* sp. nov. is taken from the Latin word for three, reflecting the division of the anterior segments of the new species, which comprise three annuli.

**Remarks.** Ten species and subspecies of *Travisia* have chaetiger 1 biannulate, chaetiger 2 triannulate and mouth in the usual position between chaetigers 1 and 2: *T. amoyanus* Yang, Wu, Wang, Zhao, Hwang and Cai, 2022; *T. araciae* Rizzo and Salazar Vallejo, 2020; *T. brevis* Moore, 1923; *T. carnea* Verrill,

1873; *T. forbesii intermedia* Annenkova, 1937; *T. japonica* Fujiwara, 1933; *T. monroi* Maciolek and Blake, 2006; *T. nigrocincta* Ehlers, 1913; *T. olens* Ehlers, 1897. In all of these the transition to posterior annulation pattern occurs before chaetiger 21, excepting *T. tribus* sp. nov. (transition to biannulate pattern on chaetigers 25–28) and *T. japonica* Fujiwara, 1933 (transition occurring chaetigers 20–29). *Travisia tribus* sp. nov. can be distinguished from *T. japonica* by having deep lateral grooves on pre-pygidial segments and in lacking crenellations and papillae on posterior-most segments (*T. japonica* has crenellations on posterior-most segments and a ring of papillae encircling the last segment).

**Distribution, habitat.** Known from 89 locations in southeastern Australia from the Great Australian Bight in the west, to eastern Australia at ~31–42° S. Depth range 14–200 m.

### *Travisia una* sp. nov.

<https://zoobank.org/urn:lsid:zoobank.org:act:60C33D9B-979A-41DB-A7A6-9E4F5736A8ED>

Figures 8–15

**Material examined.** Holotype: Australia: Eastern Bass Strait, 15.5 km SW of Pt Ricardo, Stn MSL-EG 80, 37° 53.133' S, 148° 28.933' E, 4 Jan 1991, 45 m, NMV F271088.

Paratypes: Australia: Victoria: Eastern Bass Strait, 7.3 km SSW of Cape Conran, Stn MSL-EG 116, 37° 52.65' S, 148° 42.15' E, Feb 1991, 49 m, 3, NMV F271081–F271083; Eastern Bass Strait, 7.3 km SSW of Cape Conran, Stn MSL-EG 115, 37° 52.65' S, 148° 42.15' E, Feb 1991, 49 m, NMV F60672; Eastern Bass Strait, 7.3 km SSW of Cape Conran, Stn MSL-EG 116, 37° 52.65' S, 148° 42.15' E, Feb 1991, 49 m, 1, NMV F60673; Eastern Bass Strait, 15.5 km SW of Pt Ricardo, Stn MSL-EG 80, 37° 53.133' S, 148° 28.933' E, 4 Jun 1991, 45 m, 1, NMV F63841; Eastern Bass Strait, 2.9 km SE of Cape Conran, Stn MSL-EG 112, 37° 50' S, 148° 38.9' E, Feb 1991, 29 m, 1, NMV F200619; Eastern Bass Strait, 15.5 km SW of Pt Ricardo, Stn MSL-EG 80, 37° 53.133' S, 148° 28.933' E, 4 Jan 1991, 45 m, 1, AM W54587. Non-type material: Victoria: Western Port, WBES 1733, 38° 23.0833' S 145° 27.3167' E, 29 Nov 1973, 10 m, 1, NMV F60031.

Victoria: Eastern Bass Strait, 13.3 km E of eastern edge of Lake Tyers, Stn MSL-EG 67, 37° 51.7' S, 148° 14.6' E, 4 Jan 1991, 37 m, 1, NMV F60667; Eastern Bass Strait, 4.6 km S of Cape Conran, Stn MSL-EG 58, 37° 51.43' S, 148° 43.73' E, 28 Jan 1990, 50 m, 1, NMV F63838; Eastern Bass Strait, 7.3 km SSW of Cape Conran, Stn MSL-EG 117, 37° 52.65' S, 148° 42.15' E, Jan 1991, 49 m, 4, NMV F60674; Eastern Bass Strait, 7.3 km SSW of Cape Conran, Stn MSL-EG 61, 37° 52.667' S, 148° 42.067' E, 28 Jan 1990, 48 m, 5, NMV F63842; Eastern Bass Strait, 7.3 km SSW of Cape Conran, Stn MSL-EG 62, 37° 52.67' S, 148° 42.067' E, 28 Jan 1990, 48 m, 3, NMV F63837; Eastern Bass Strait, 7.3 km SSW of Cape Conran, Stn MSL-EG 88, 37° 52.65' S, 148° 42.15' E, 4 Jan 1991, 49 m, 5, NMV F60668; Eastern Bass Strait, 7.3 km SSW of Cape Conran, Stn MSL-EG 89, 37° 52.65' S, 148° 42.15' E, 4 Jan 1991, 49 m, 4, NMV F60669; Eastern Bass Strait, 7.3 km SSW of Cape Conran, Stn MSL-EG 90, 37° 52.65' S, 148° 42.15' E, 4 Jan 1991, 49 m, 4, NMV F60670; Eastern Bass Strait, Stn VC 41 A3, 37° 31.25' S, 148° 2.533' E, 8 Jan 1998, 10 m, 5, NMV F139260; Eastern Bass Strait, Stn VC 45 A1, 37° 28.3' S, 149° 2.567' E, 9 Jan 1998, 10 m, 1, NMV F139390.

**Diagnosis.** Branchiae first present on chaetigers 3–6, 8–14 branchiate segments; all chaetigers uniannulate.

**Description.** Body comprising 20–25 segments; 19–24 chaetigers; 0–3 achaetous posterior segment(s), 3.6–11 mm long, 1.5–3.6 mm maximum width at chaetiger 12; holotype 24 chaetigers, no achaetous posterior segments; 8.2 mm long, 2.3 mm maximum width at chaetiger 12. Body fusiform, evenly papillated, reaching greatest diameter chaetigers at chaetigers 15–20 (figs 8–11).

Prostomium longer than maximum width; a pointed cone (fig. 10) although often partially contracted. Mid-ventral groove absent. Peristomium undivided. Mouth located between chaetigers 1 and 2.

Chaetiger 1 and all subsequent chaetigers uniannulate without ridges; no posterior annulation pattern change. Branchiae present (but minute and difficult to observe); much shorter than body diameter; smooth. Branchiae first present on chaetiger 3–6; present on 8–14 chaetigers (8 in the holotype) and are longest in median chaetigers; number of posterior abbranchiate segments: 3–8 (7 in the holotype).

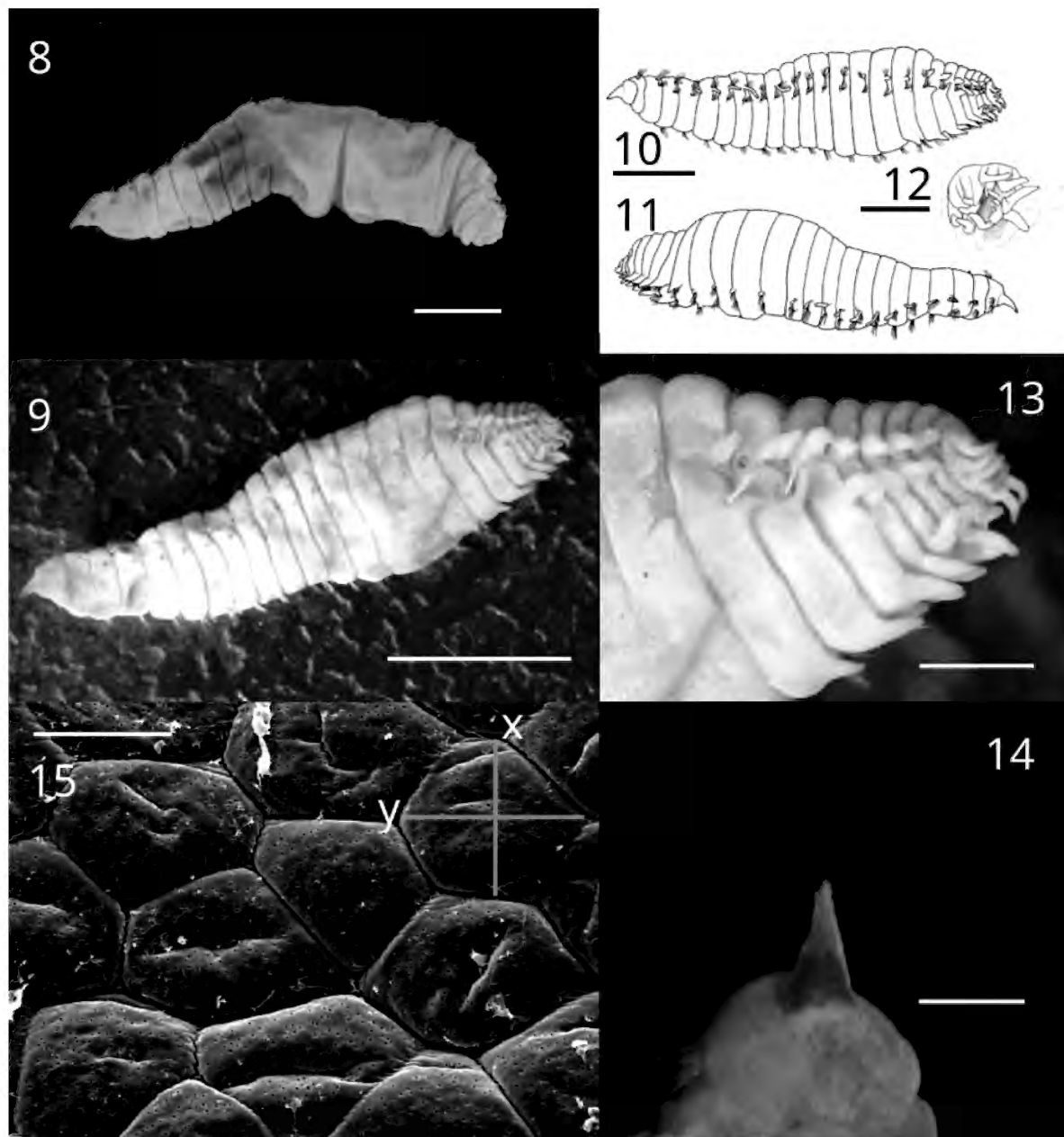
Epidermal papillae forming a regular cover of raised polygons, each with 125–155 pores. Papillae width about equal to length (~60 µm) (width measured in circumferential direction around the worm, dimension y in fig. 15, length along the worm, dimension x in fig. 15). Parapodial lobes present; notopodial lobes commence chaetiger 15–17 (16 in the holotype); neuropodial lobes commence chaetiger 15–17 (16 in the holotype), present as prominent roughly triangular lappets over posterior-most 8–10 segments. Interramal pores when visible first present chaetiger 1, last present chaetiger 13–15 (not observable in the holotype). Nephridiopores first present chaetiger 3 (but not visible on many specimens including the holotype). Capillary chaetae smooth. Anal tube equal to length of 2 posterior segments. Pygidial lobes 9–22 (10 in the holotype), digitiform and unequal in width (figs 12, 13).

**Staining pattern.** Prostomium darkly stained uniformly with methylene blue (fig. 14), body, parapodial lobes and pygidial lobes uniform dark stain, only chaetigers 2 and 3 incompletely stained, branchiae unstained.

**Remarks.** *Travisia una* sp. nov. is readily recognised: it is the only species in the genus known in which all segments, both anterior and posterior, are without annulations. The presence of at most 14 pairs of branchiae commencing on chaetiger 3 or later and a short body of 19–24 chaetigers is also distinctive. *Travisia una* sp. nov. is also easily distinguished from the other known Australian species of *Travisia*: it is the only one with branchiae commencing on chaetiger 3 (all other Australian *Travisia* have branchiae first present on chaetiger 2), the only one with 14 or fewer pairs of branchiae (the others all have at least 23 pairs) and the only one with uniannulate segments throughout.

**Etymology.** The species name of *Travisia una* sp. nov. is taken from the Latin word for one, reflecting the segments of the new species, which comprise a single undivided annulus.

**Distribution, ecology.** South-eastern Australia: far-eastern Bass Strait. Depth range 10–50 metres.



Figures 8–15. *Travisia una* sp. nov. 8 – dorsal view preserved specimen NMV F200619 (paratype); 9 – ventral view preserved specimen NMV F271088 (holotype); 10 – ventral view NMV F200619 (paratype); 11 – lateral view NMV F200619; 12 – pygidium detail NMV F200619 (paratype); 13 – posterior detail ventral view preserved specimen NMV F271088 (holotype); 14 – methylene blue staining pattern prostomium ventral view NMV F271081 (paratype); 15 – SEM epidermal papillae from dorsum chaetiger 6 NMV F200619 (paratype). Image credits 8, 9, 13, 14 – Robin Wilson; 10–12 – Kate Nolan; 15 – Stepan Vodopyanov. Scale bar figs 8–11: 2 mm; 9–11: 2 mm; 12–14: 0.5 mm; 15: 50  $\mu$ m; papilla measurements: x – dimension on papilla oriented with length of worm, y – dimension on papilla oriented with circumference of worm.

**Key to Australian species of *Travisia***

1. Posterior parapodia similar to anterior parapodia; capillary chaetae hirsute ..... *T. lithophila* Kinberg, 1856
- Posterior parapodia developed into prominent lateral lappets; capillary chaetae smooth ..... 2
2. All chaetigers uniannulate; branchiae first present chaetigers 3–6 ..... *T. una* sp. nov.
- Most chaetigers bi- or triannulate; branchiae first present chaetiger 2 ..... 3
3. Chaetiger 1 uniannulate or weakly biannulate; annulation pattern changes from triannulate to biannulate at chaetigers 19–20; 0–4 posterior abbranchiate segments ..... *T. oksae* Hartmann-Schröder and Parker, 1995
- Chaetiger 1 biannulate; annulation pattern changes from triannulate to biannulate at chaetigers 25–28; 6–9 posterior abbranchiate segments ..... *T. tribus* sp. nov.

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## A new species of *Astrosarkus* from Western Australia including new Mesophotic occurrences of Indian Ocean Oreasteridae (Valvatida, Asteroidea)

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### Abstract

Mah, C.L. 2023. A new species of *Astrosarkus* from Western Australia including new Mesophotic occurrences of Indian Ocean Oreasteridae (Valvatida, Asteroidea). *Memoirs of Museum Victoria* 82: 143–165.

*Astrosarkus lu* n. sp. (Oreasteridae, Valvatida; Asteroidea) is described in addition to new *in situ* observations. Further occurrences of Indo-Pacific Oreasteridae are surveyed, with emphasis on distributions in the relatively poorly understood mesophotic zone.

### Keywords

Indian Ocean, deep-sea, Valvatida

### Introduction

The mesophotic zone is a subject of increasing interest to conservation biology (e.g. Turner et al., 2019); evidence has been presented that this region is both a distinct, new zone with a distinctive fauna, as well as a possible refugia for shallow reefs (Semmler et al., 2017). The mesophotic zone has been delineated variously, but is defined herein as 30–150 m depending on region, a transition zone between shallow, reef ecosystems and deeper water habitats that historically has been difficult to investigate owing to being out of reach of shallow-water scuba diving and too shallow for conventional deep-sea sampling technology (e.g. large submersibles) (Baker et al., 2016).

Characterisation of the biological diversity in this newly discovered but poorly understood ecological zone is necessary to understand its impact on coral ecosystems (e.g. Turner et al., 2019). High diversity in coral species has been associated with mesophotic settings (Muir et al., 2018). Study of faunal composition of taxa in the mesophotic zone has suggested a mix of species from shallow and deeper waters (e.g. antipatharians in Bo et al., 2019). Numerous taxonomic studies have resulted in the discovery of undiscovered marine species, including corals (e.g. Breedy & Guzman, 2013), fishes (e.g. Tornabene et al., 2016) and other metazoans (e.g. Guerra Garcia & Ah Yong, 2020). Echinoderm diversity shows high occurrence of potentially endemic mesophotic taxa and distinct species assemblages in the South Pacific (Mecho et al., 2019, 2021).

Within tropical reef settings, asteroids occupy prominent ecological roles, including those of predators affecting community structure, such as the crown-of-thorns sea star (*Acanthaster* spp.) (Birkeland and Lucas, 1990). Members of the Oreasteridae, which are sister taxa with *Acanthaster* (e.g., Yasuda et al., 2006; Mah and Foltz, 2011), are familiar in these

habitats but are not well studied and many similarly occupy significant ecological roles. The cushion star *Calcita novaeguineae*, for example, can affect scleractinian coral community structure significantly (Glynn and Krupp, 1986). The shallow-water Indo-Pacific *Protoreaster nodosus* are known as important consumers and bioturbators in sedimentary habitats (e.g. Scheibling and Metaxas, 2008). Mesophotic observations of oreasterids, especially their diversity, is an important consideration within the context of coral reefs and related settings.

Among the most distinctive of mesophotic asteroids is the oreasterid *Astrosarkus*, which was one of the earliest known asteroids determined to specifically inhabit this depth zone. *Astrosarkus idipi* was first described by Mah (2003) from mesophotic settings in Palau (67 m), the Marshall Islands (125 m), and Reunion Island (Indian Ocean, 185–200 m). It has since been discovered in the Okinawa region of Japan and American Samoa (Kogure et al., 2009). Known specimens are large (up to 30 cm in diameter) and possess thick bodies with a soft but firm, fleshy body wall. They occur widely in the South Pacific and Indian Ocean, but have only been observed at mesophotic depths (67–210 m). One of the few other oreasterids present at mesophotic or deeper-water faunas is the South Pacific *Acheronaster tumidus* H.E.S. Clark 1982, which is known from 110–300 m from New Zealand, southern Australia and New Caledonia, with a possible second species observed from Rapa Nui at a depth of 269–300 m (Mah, 2021).

Recent exploration and sampling of deeper-water mesophotic habitats has revealed that in addition to *Astrosarkus*, multiple commonly encountered shallower-water oreasterid species are evident. New material discovered in the Museum Victoria during visits in 2017 and 2023, additional material from the National Museum of Natural History in Washington,



DC (USNM), as well as newly acquired video imagery from multiple sources further elaborate on the unusual *Astrosarkus*, as well as mesophotic occurrences and other biology in the Oreasteridae. Occurrence and ecological observations will provide further insight into mesophotic asteroid faunas.

## Materials and methods

Material referenced herein is deposited at the Museum Victoria (NMV) in Melbourne, Australia, the USNM, the California Academy of Sciences in San Francisco, CA (CAS) and the Muséum national d'Histoire naturelle in Paris, France (MNHN).

## Systematics

### OREASTERIDAE Fisher 1908

**Diagnosis.** Body variable, ranging from pentagonal, cushion-shaped round bodies to more strongly stellate forms. Disk and arms strongly arched, with large coeloms in large specimens ( $R > 4.0$  cm). Abactinal skeleton reticulate papular regions well developed. Marginal plates well developed but variably obscured by heavily granulate dermal layer, well-developed body wall or other covering. Surface covered by large primary spines, tubercles and/or other accessory structures. Adambulacral plates tall, articular surfaces prominent. Ambulacral and adambulacral ossicles stout, closely spaced, forming diamond-shaped chamber over ambulacral groove. Actinal papulae absent. Calcareous interbranchial septum present. Coelomic openings large. Upturned, terminal arm tip. Spicules in tube feet. Modified from Marsh and Fromont (2020) and Mah (2003).

**Comments.** The Oreasteridae are among the most prominent of shallow-water tropical Indo-Pacific and tropical Atlantic Asteroidea, owing in part to their relatively large size (reaching approximate diameter of 30 cm), conspicuous spination and eye-catching coloration (e.g. *Pentaceraster* species) (Marsh and Fromont, 2020). Many shallow-water species, such as the tropical Atlantic *Oreaster reticulatus*, are endangered by tourist fisheries and other human-related activities (e.g. Scheibling and Metaxas, 2010). Many oreasterids are known from shallow-water settings, but the lower limits of their depth distributions are not well understood. Several shallow-water species, known best from reef habitats, display bathymetric distribution into mesophotic depths (e.g. Mah, 2017, and species herein).

### *Astrosarkus* Mah 2003

**Diagnosis.** Body pentagonal to weakly stellate,  $R/r = 1.25$ – $1.4$ . Arms and disk confluent with rounded arm tips, with thick smooth, soft “flesh” imbued with channels through the body wall; highly modified abactinal, marginal and actinal plates. Surface has continuous granular cover. Larger accessory structures present or absent. Papular areas extensive on discrete mound-like regions on abactinal, lateral surface. Internal, fixed, spine-like processes on ambulacrals. Furrow spines 10–11, subambulacral spines, 2–5. Modified from Mah (2003).

**Comments.** This account reports on new specimens and observations from Australian as well as other Indian Ocean

localities. At the time of description, known distribution was limited to the tropical South Pacific to Reunion Island. *Astrosarkus* is now known to be widely distributed at mesophotic depths throughout the tropical Indo-Pacific (30–150 m), including southern Japan and Guam (Kogure et al., 2009) to the Marshall Islands/South Pacific, the coast of northern Australia (Queensland and Western Australia) and the western Indian Ocean (Reunion Island, Mayotte, Maldives).

### *Astrosarkus idipi* Mah 2003

Figure 1a–e, Figure 2a–d, Figure 3a–b

Mah 2003: 685; Kogure et al., 2009: 73; Wheeler and Pennak, 2013: 94; Conand et al., 2018: 114; Mulochau et al., 2019: 21; Mulochau et al., 2020: 17.

**Diagnosis.** Body massive, lateral edge rounded, outline weakly stellate, arm tips round. Thorny tubercles absent. Furrow spines 10–11, subambulacral spines 2–5, but only approximately 1.5–2 times the size of the adjacent furrow spines.

**Comments.** The collected specimen represents the first individual recovered from the Maldives and the first from the north Indian Ocean. The first such specimen from the Indian Ocean was the paratype from the Indian Ocean (Mah, 2003). The red/orange and white morphotype in Fig. 1 has been documented from Guam (Kogure et al., 2009). As summarised herein, this species is widespread throughout the Indo-Pacific, extending from southern Japan, Guam, New Caledonia and northern Australia to the western Indian Ocean (Mayotte, the Maldives, and Reunion Island). The observed colouration appears variable and may represent infraspecific variation. Further testing for cryptic species is desirable.

**Australian individuals (based on video).** The Cape York individual (referred to as Cape York video under Videos Referenced) displays a solid red-orange on the abactinal surface with large, mottled white patches along the lateral surface and smaller irregular patches present on each of the convex mounds on the abactinal surface. The video captures only two arms and the lateral surface (Fig. 3a).

Body shape stellate, or weakly so. Arms short, but relatively well developed. A species identified by the arms distinctly set off from the disk with the abactinal surface covered by pronounced tumid convexities covered by small, translucent papulae, approximately 500–700 per mound. Singular discrete irregular circular areas possibly pedicellariae, but exact determination is unclear. Ambulacral furrow upturned along arm radius extending to abactinal surface.

The Tegrosse Reef video (Fig. 3b) captured a view of the abactinal surface, but with no closeups. Appearance of this specimen was consistent with the description of this species as outlined in the type (Mah, 2003) with a massive body, short, thick arms with rounded tips and the surface covered by numerous shallow mound-shaped regions, developed in transverse series across the arms.

**Colour trends.** Colour variation in *A. idipi* follows two general trends. One color morph is solid orange variably with white highlights and/or mottling on the papular regions, especially on

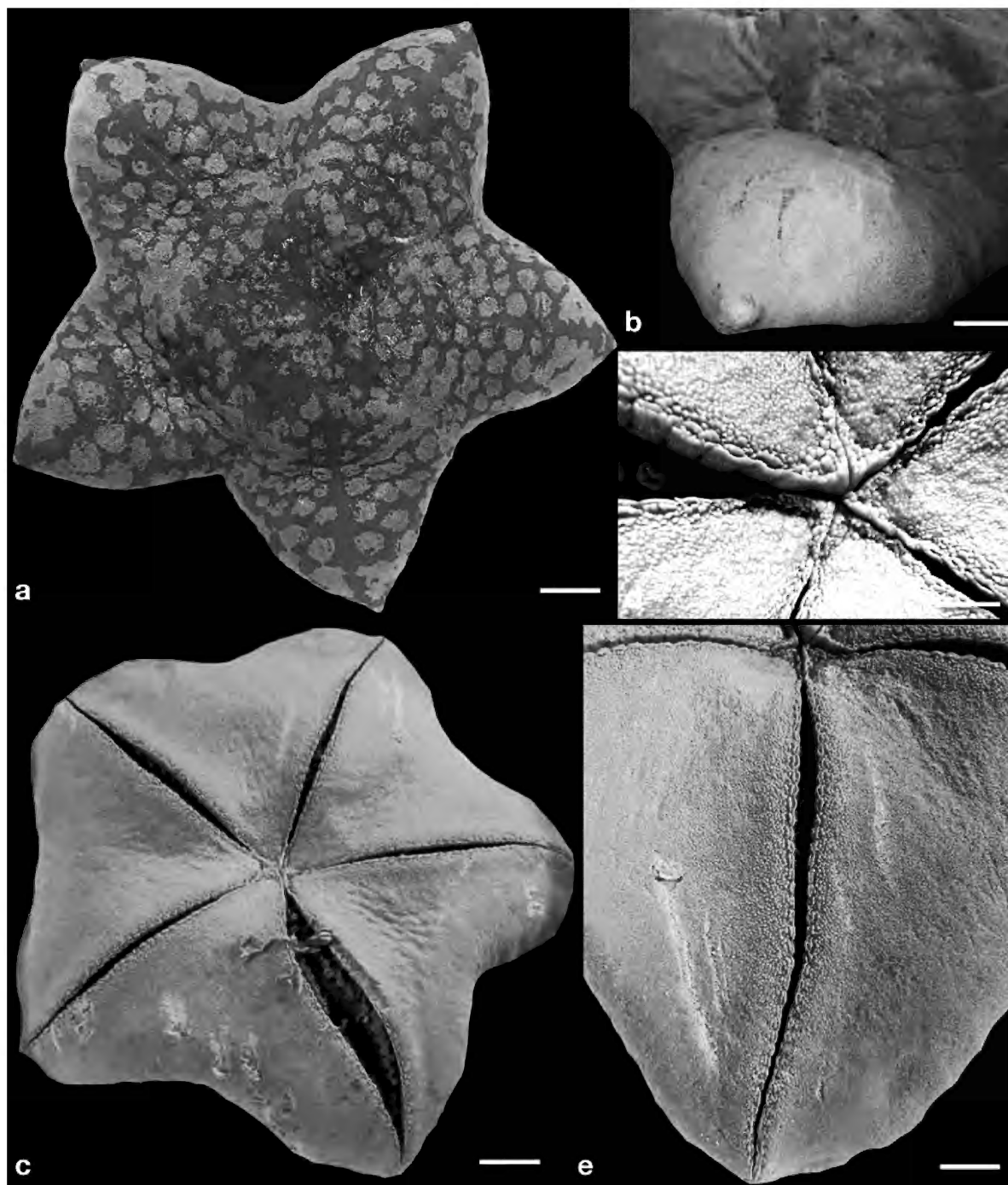


Figure 1. *Astrosarkus idipi* Maldives, specimen ID MAL1\_330. a, Abactinal surface, specimen showing living coloration. Scale bar=4.0 cm; b, Abactinal surface of arm region. Scale bar=2.0 cm; c, Actinal surface, preserved specimen. Scale bar=4.0 cm; d, Actinal surface, oral region, closeup. Scale bar=1.0 cm; e, Actinal surface, showing furrow, adambulacral plates. Scale bar=2.0 cm.



Figure 2. *Astrosarkus idipi*. Maldives/Mayotte. a, *Astrosarkus idipi* (white/red form) from Mayotte, 75 m. Photo courtesy Thierry Mayotte; b, *Astrosarkus idipi* (white/red form) from Maldives. Photo courtesy Paris Stefanopoulos; c, *Astrosarkus idipi* (orange form) from St. Leu, Reunion Island. Photo by Patrick Plantard; d, Orange form with white highlights from Lifou Island, New Caledonia. Photo courtesy Laurent Ballesta.

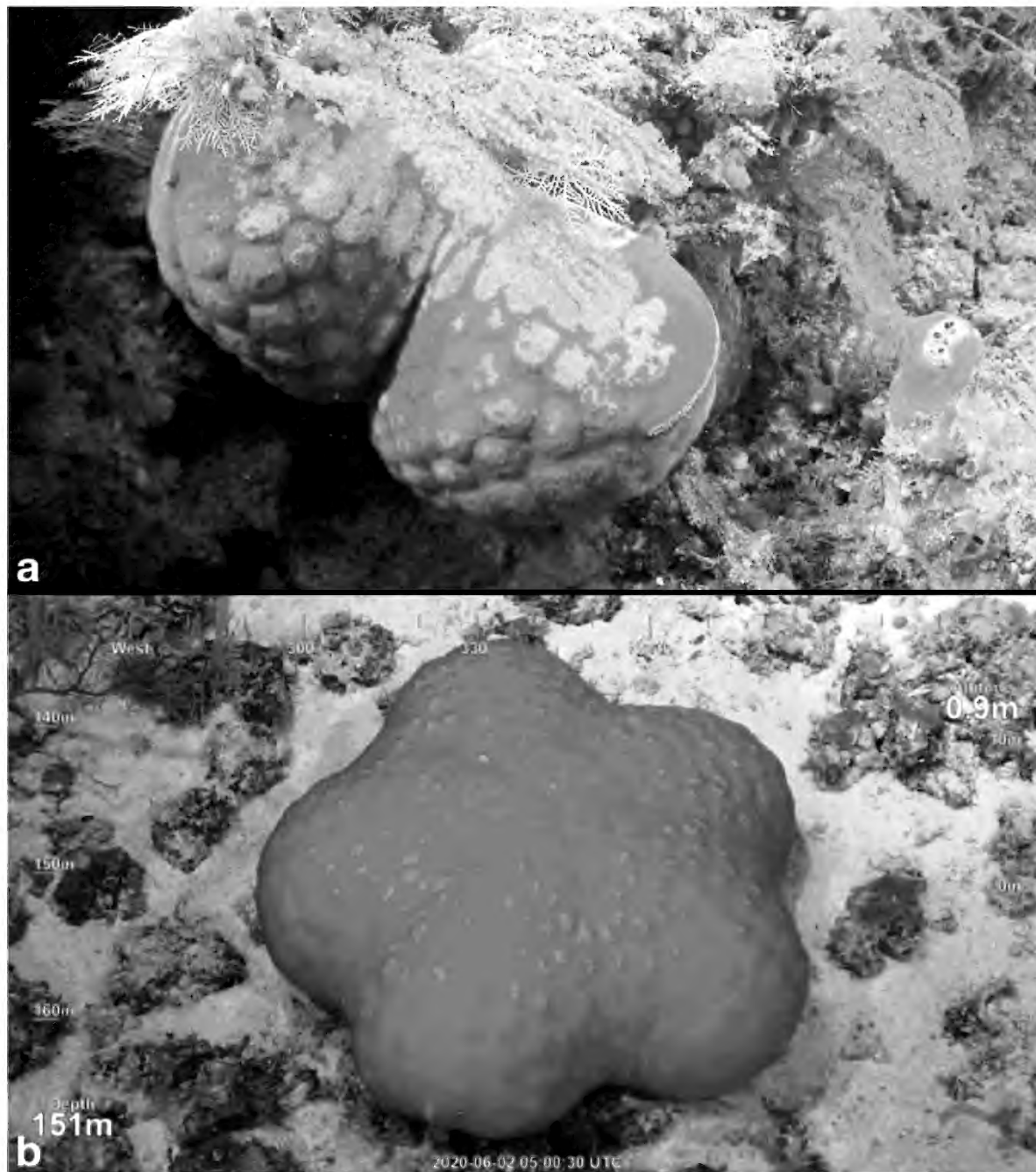


Figure 3. *Astrosarkus* spp. from Australia. a, *Astrosarkus* sp. Northern Depths, Great Barrier Reef; b, *Astrosarkus idipi* from Coral Sea Marine Park. Distance between lasers is 10.0 cm.

the actinal surface around the mouth. This form has been observed from New Caledonia, Palau, Enewetak, Okinawa, Cape York, and Tegrosse Reef in the Coral Sea, off Queensland, Australia. The second colour form is primarily bright orange or red with bright white papular regions, which are confluent and forming an almost mixed colouration. This latter form has been observed in Guam, Mayotte, Maldives and Reunion Island. Discerning trends with colouration is difficult, given the relatively few observations at hand, but most of the deeper water individuals seem to be the solid-orange colour variant.

**Ecological comments.** The Cape York, Australia, video observation shows this species *in situ* on a rocky underhang in close proximity to a cluster of abundant encrusting metazoans, including octocorals, hydroids, sponges and possibly stylasterid corals. While a clear predation event was not evident, it seems likely that one of these types of metazoans is/are a prey item for this species. This would be consistent with an image of *Astrosarkus* (Fig. 2b) with one arm over what appears to be sponges and other encrusting organisms in Mayotte at 91 m.

The specimen from South Diamond Islet/Tegrosse Reef, off Queensland, Australia was observed amidst a mixed field of rhodoliths (unattached algal nodules) and sandy sediment at 151 m. Its coloration, surface texture and absence of apparent spination or tubercles (although closeups were not obtained) suggested that this was *A. idipi*. Based on the laser scale of 10 cm, this individual was approximately  $R=20.0$ ,  $r=15.0$  cm, consistent with other occurrences of this species. A small unidentified pufferfish, *Canthigaster*, was observed adjacent to the animal during the video, but its relationship (which could simply be incidental) to *Astrosarkus* is unclear.

The individual observed on Lifou Island, New Caledonia (110 m) is consistent with the colour and overall shape (Mah, 2003) of individuals from Palau and the South Pacific. The degree of arm development seems slightly more pronounced in this individual than in others. This specimen was observed on hard substrate covered by epizoid and encrusting organisms.

**Occurrence/distribution.** Palau, American Samoa, Southern Japan, Maldives, Mayotte, Reunion Island, 67–210 m

**New occurrence.** northeastern coast Australia (Queensland), 151 m.

**New occurrence.** Lifou Island, New Caledonia, 110 m

**Specimen referenced.** MAL1\_330 (unique ID number), Addu, Maldives, 85 m. MAL 1 330, 22/9/2022, site D. 1 wet spec.  $R \sim 18.0$ ,  $r \sim 12.5$

**Videos referenced.** 1. Tegrosse Reef, South Diamond Islet Australia, -17.80118148° S, 150.63650088° E, 151 m. Observed by R/V *Falkor*, ROV SuBastian, dive 365. Video: <https://www.youtube.com/watch?v=LlIPt9v0URM&list=PLJGVQI3okzah21Nq70K57SJs1D54QjkX&index=6&t=22855>

2. Cape York, 500 m-tall detached reef offshore of Cape York, off Queensland, Australia, -12.39211352° S, 143.85684846° E, 116 m. Observed by RV *Falkor* voyage FK200930, Northern Depths of the Great Barrier reef, ROV SuBastian, dive S0401. Video: <https://www.youtube.com/watch?v=RnUVnNX7yrw&list=PLJGVQI3okzahbyrJeAfGKLJ2SX-3fu4it&index=15&t=5731s>

### *Astrosarkus lu* nov. sp.

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Figure 4a-g

**Etymology.** This species is named for Dr. Chung-Cheng Lu, curator emeritus at the Museum Victoria, who collected the specimen, in honour of his contribution to Australian invertebrate zoology. The surname Lu is held in apposition.

**Diagnosis.** Large pointed tubercles on the abactinal and lateral surface. Furrow spines thick, 4–7; subambulacral spines mostly 5–6, quadrate to round in cross-section in irregular series, each three times as thick as the furrow spines. Region adjacent to the adambulacral spination with numerous, relatively short bivalve pedicellariae.

**Comments.** This is the first specimen occurrence of *Astrosarkus* in Australia and as with *A. idipi*, *Astrosarkus lu* n. sp. occurs at mesophotic depths. This species shows small, thorn-like spines on the abactinal and lateral surfaces, as well as having differing numbers of adambulacral armaments, notably fewer furrow spines, 4–7 rather than 10–11 as in *A. idipi*, as well as having much larger and differently shaped subambulacral spines. These suggest a defensive function that might not apply to the more widespread *A. idipi*. Pedicellariae in *A. lu* n. sp. are similar in appearance but differ in having more elongate valves than *A. idipi*. Although a dissection of the holotype was not attempted, the fleshy material composing the body wall appears identical to the one present in *A. idipi*.

Although deck shots of this species were taken, colour was difficult to interpret, but appeared red to magenta on the abactinal surface with a white or light actinal surface. Other images of other *Astrosarkus* spp. studied herein showed no individuals with comparable colour or spination.

**Occurrence.** Off Western Australia in the Timor Sea, 83–84 m.

**Description.** Body pentagonal ( $R/r=1.25$ ) thick (height=5.5 cm), stout, covered in smooth flesh which obscures all but adambulacral spination and abactinal tubercular spines. Body solid to the touch, with flesh pushed unevenly on surface. Arm terminus upturned.

Abactinal surface forming a reticulated pattern composed of smooth granule-infused dermis and large distinct papular regions, 100–1000 papulae per area (approximately 1–2 cm x 1–2 cm). Papular regions vary in size and extend onto lateral surface, with largest areas along peripheral disk region adjacent to periphery. Smaller, more discrete regions present more centrally on disk and arms. Distinct elongate papulae emerge from about half of papular pores examined. Non-papular regions composed of dense granule-infused dermis with approximately five granules on a 1.0 mm count. Single tubercular spines with pointed tips, interspersed throughout abactinal and lateral surfaces, most of these present on non-papular surface but with some papular pore regions bearing a single spine. Madrepore round, polygonal, sitting on raised area on abactinal surface, base surrounded by tissue. Sulci relatively shallow.

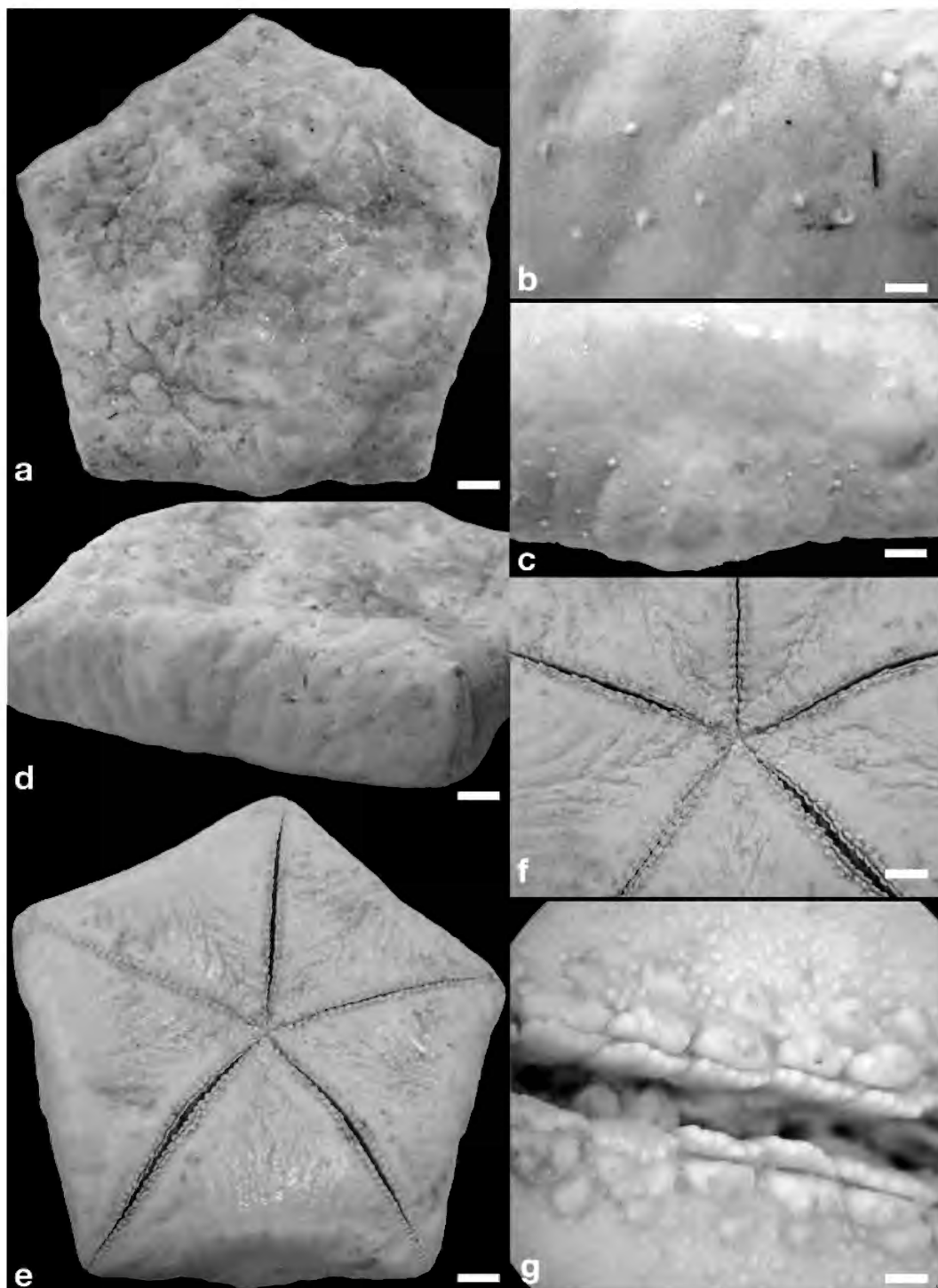


Figure 4. *Astrosarkus lu* n. sp. Scale unavailable. a, Abactinal view; b, Closeup showing spiny tubercles on marginal plates; c, Lateral view showing spiny tubercles on marginal plates; d, Lateral view; e, Actinal surface view; f, Closeup of oral region on actinal surface; g, Closeup of adambulacral armature, furrow spines, etc.



Marginal plates not evident from external surface but covered by thick tissue. Lateral surface appears to be distinguished by weakly expressed elongate segments, approximately 14 per interradius. Each segment covered with a similarly elongate papular region, containing 500–1000 papulae on each. Tubercle-like spines present along lateral surface with regular occurrence on both papular and non-papular areas. Terminal plate pronounced, triangular with rounded edges. Ambulacral grooves distinctly present along lateral surfaces on each radii.

Actinal surface demarcated by absence of papular regions, ostensibly beginning at lower end of marginal “segments” on lateral surface. Actinal intermediate area dominated by granule-infused dermis. Actinal–lateral areas relatively texture free but approaching midway to proximally, these areas have shallow grooves in addition to distinct valleys and dendritic indentions within each actinal intermediate region.

Furrow spines 4–7, mostly five or six, each spine blunt, thick, quadrate in cross-section with each array in straight to weakly concave formation. Subambulacral spines in two irregular rows, the one adjacent to furrow spines composed of two to three blunt spines each approximately three times the thickness of a furrow spine, the one proximal to the mouth with tapered tips, almost acorn-like in shape, these becoming more cylindrical in cross-section distally adjacent to the terminus. The second subambulacral spine mostly single but exceptionally with two, both of these adjacent to the actinal intermediate region. Region adjacent to the adambulacral spination with numerous, relatively small bivalve pedicellariae, approximately 1.0 mm in length, approximately 6–10 associated with each subambulacral spine. Coarse, larger quadrate to polygonal granules present, approximately three counted along a 1.0 mm line.

Oral plates with closely appressed furrow spines, nine per side, each with rounded, blunt tip, quadrate to round in cross-section, with some spines twice as thick as others. A single spine observed on the oral plate projecting into the mouth. Oral plate “surface” covered with irregularly large and thick spines, 10–15, similar in stature to subambulacrals but also irregular in size, shape, all closely appressed to one another. Actinal intermediate regions adjacent to adambulacral furrow spination with higher numbers of pedicellariae and greater numbers of larger granules.

**Material described.** Holotype, NMV F 242065 Australia, Western Australia, Timor Sea, North West Shelf, 12° 05' 12" S – 125° 54' S, 125° 37' E – 125° 35' E. 83–84 m. Coll. Chung Chen Lu. 1 April 1981. RV *Hai Kung*, Cruise number 70040102. 1 wet spec. R=16.5, r=13.2, h=5.5 cm (measured from underside).

### ***Choriaster* Lütken, 1869**

#### ***Choriaster granulatus* Lütken, 1869**

Figure 5a–b

Lütken, 1869: 35; Goto 1914: 604; Fisher 1919: 367; Domantay and Roxas 1938: 217; Hayashi 1939: 424; Chang et al., 1964: 61; A.M. Clark 1967: 37; Liao 1980: 154; Marsh and Marshall 1983: 675; Jangoux 1986: 124; Marsh and Fromont 2020: 295

**Diagnosis.** Body stellate ( $R/r=2.6$ ), strongly thickened, arms round in cross-section. Interradial arcs acute. Surface smooth covered by finely granulate dermal covering. Reticulate skeleton present but covered by a thick, dense fibrous tissue bearing minute plates. Although obscured by granulate dermal covering, abactinal, marginal and actinal plates well developed. Papular pores present only on abactinal surface, terminating at superomarginal plates. Furrow spines slender, 8–9; subambulacral spines large, flat and truncate, three to four (exceptionally five). Modified from Marsh and Fromont (2020), Mah (2003).

**Comments.** A readily recognizable species, primarily encountered in shallow-water coral-reef related habitats, depth range, 0–40 m (Marsh and Fromont, 2020). Recent ROV video accounts from the Indian Ocean discovered this species in the Maldives at 60–70 m and in the Comoros at a depth of 80 m, indicating that the lower limit of this species likely occurs at mesophotic depths. Mesophotic individuals were observed on rocky substrates covered by epizoic, encrustations adjacent to light, sandy sediment.

Biology of this species is poorly understood. Spawning has been reported in April with planktotrophic larvae. They scavenge on dead fish and other animals, and likely feed on microbial biofilm (Marsh and Fromont, 2020).

Color variation ranges from pink with light to dark papular regions. Specimens from the Indian Ocean, especially Tanzania, Madagascar and adjacent areas, as well as those in the Red Sea, seem to show especially dark papular regions with strong contrast to the lighter surrounding pink to peach coloration.

**Occurrence.** Widely occurring throughout the Indo-Pacific. Southern China and Japan (Ryukyu Islands), Vietnam, Singapore, eastern Caroline Islands, New Caledonia, Fiji, Tonga, Australia on the Great Barrier reef and Ashmore reefs off Western Australia, Indonesia, Papua New Guinea, Philippines to the Red Sea, and east Africa. 0–40 m.

**Depth/new occurrences.** Maldives to 60–70 m

Moheli Island, Comoros at 80 m.

**Material/video referenced.** Comoros Video, Moheli Island (Comos) 12° 27.531" S, 43 38.286" E, 80 m. Observed 10 Oct 2018. Image by CEPF/ACEP Comoros Biodiversity Project.

### ***Culcita* Agassiz 1836**

**Diagnosis.** Adults large with massive pentagonal, strongly arched body and confluent arms. Abactinal-lateral and actinolateral edges round, producing a nearly circular appearance. Marginal plate limits and body surface concealed by thickened, granule-invested dermis. Pore areas well developed but irregular to confluent. Actinal granules, granule-invested dermis dense, obscuring limits of the plates. Modified from Marsh and Fromont (2020).

Small individuals of *Culcita* are more flattened and pentagonal and appear more “goniasterid-like” (Kano et al., 1991).

**Comments.** *Culcita* includes three accepted species, *C. novaeguineae*, *C. coriacea* and *C. schmideliana*, known from Indo-Pacific, Red Sea and Indian Ocean habitats respectively.

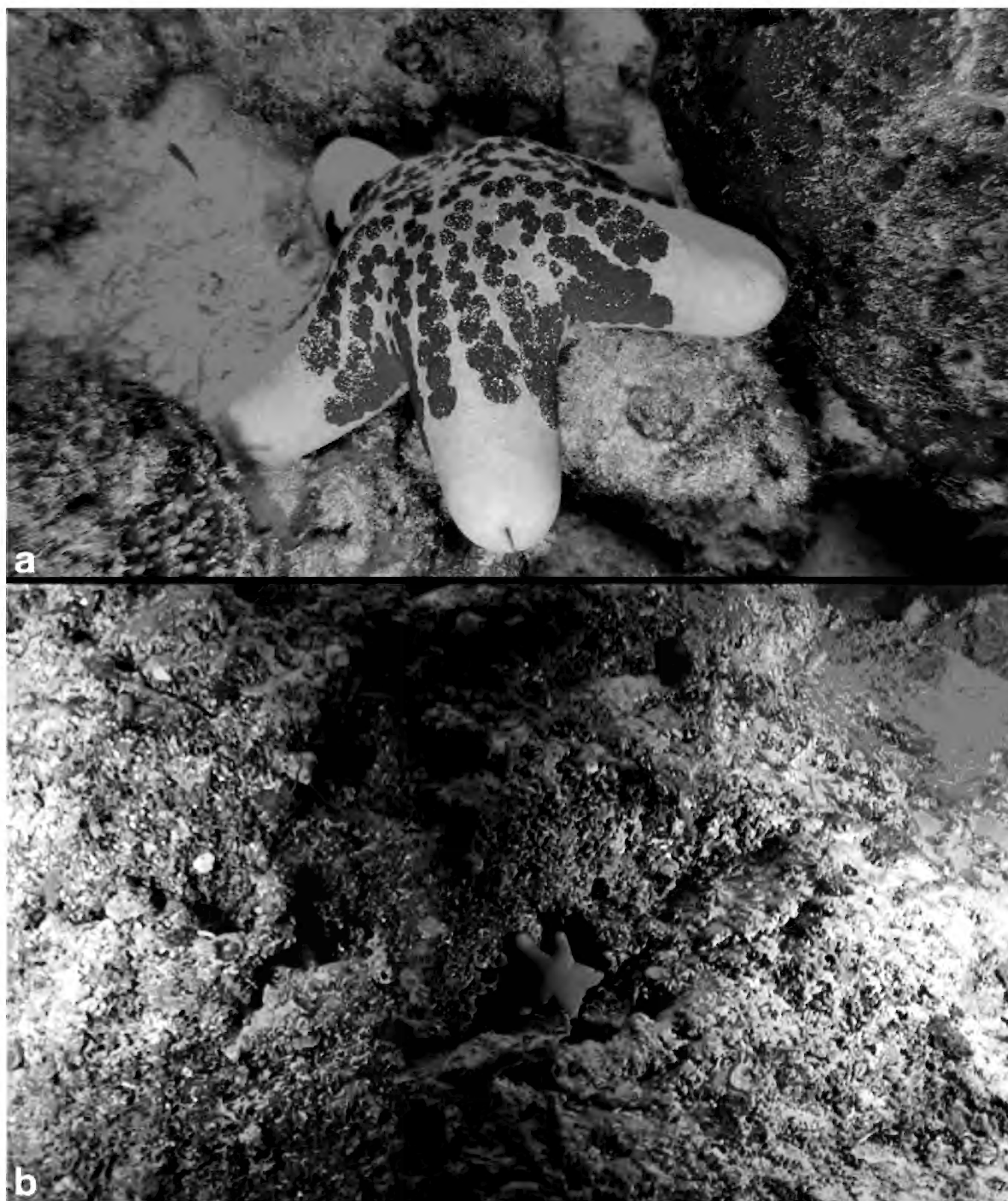


Figure 5. *Choriaster granulatus* a, *In situ* image from Comoros, 80 m. Image courtesy Comoros Biodiversity Project; b, *In situ* image from Maldives, 60–70 m. Image courtesy Maldives Ocean Research Expedition.



### *Culcita novaeguineae* Müller and Troschel 1842

Figure 6a

*Culcita novaeguineae* Müller and Troschel 1842: 38; Sluiter 1895: 57; Döderlein 1896: 310; H.L. Clark 1908: 201; Goto 1914: 507; Fisher 1919: 360; H.L. Clark 1921: 32; Djakonov 1930: 247; Livingstone 1932: 265; Engel 1938: 10 (var. Leopold); Domantay and Roxas 1938: 215; A.M. Clark & Rowe 1971: 34, 54; Liao 1980: 154; Jangoux and deRidder 1987: 90. Marsh and Fromont 2020: 400.

*Goniodiscus sebae* Müller and Troschel 1842: 58.

*Hosea spinulosa* Gray 1847: 78.

*Culcita pentangularis* Gray 1847: 74.

*Culcita pulverulenta* Perrier 1869

*Hippasteria philippinensis* Domantay and Roxas 1938: 209.

**Diagnosis.** Body shape pentagonal disk, strongly arched, arms confluent. Abactinal and marginal plates concealed by thick granule-covered dermis. Papular regions large and variably confluent, with distinct papulae-free region laterally adjacent to contact with marginal plates. Spinelets or tubercles present on papular areas. Expression of spines and tubercles varied. Actinal region covered by dermis invested with coarse granules, tubercles and/or short, conical spines. Modified from Marsh and Fromont (2020).

The mesophotic specimen observed was red with white mottled papular regions and dark colored tubercles (Fig. 6a).

**Comments.** *Culcita novaeguineae* is widespread. This species shows a wide range of variation consistent with its widespread distribution. Preliminary data suggests a cryptic complex within this species (G. Paulay, pers. comm).

*Culcita novaeguineae* is known primarily as a shallow-water reef species, with most occurrences under 30.0 m (e.g. Glynn and Krupp, 1986; Rowe and Gates, 1995; Marsh and Fromont, 2020). Video observations by the ROV SuBastian has shown this species at 99 m depth from off Queensland, occurring on a coarse, sandy bottom with rhodoliths and algal cover. No clear character differences in colour, spination, shape or size were observed on the individual imaged. No specimen was collected.

**Occurrence.** Widely distributed throughout the Indo-Pacific Ocean. Hawaiian Islands, southern Japan, southern China and Taiwan, southeastern Polynesia, Pitcairn Island to Philippines, Indonesia, north coast of Australia from Western Australia to Queensland, Papua New Guinea, east to east Africa, the Andaman Islands and southeast Asia.

**New mesophotic occurrence.** Off Queensland Australia 99.0 m depth.

**Video observation.** Bowl Slide Australia, 125 km offshore from Townsville, Queensland, Australia, -18.38805116° S, 147.66887222° E, 99 m. ROV SuBastian, dive 394, FK200930.

### *Culcita schmideliana* (Bruzellius, 1805)

Figure 6b–c

*Asterias schmideliana* Bruzellius 1805: 11.

*Culcita schmideliana* Gray 1840: 276; Perrier 1875: 266 (74); Döderlein 1896: 315 (with varieties); Simpson and Brown 1910: 53; Clark and Rowe 1971: 41; Jangoux 1973: 18; A.M. Clark and Courtman-Stock 1976: 67; Marsh and Marshall 1983: 675; Jangoux 1985: 31; Rowe and Gates 1995: 99; Marsh and Fromont 2020: 402.

**Diagnosis.** Distinct papular free area laterally adjacent to the marginal plates. Distinct prominent tubercles and/or spines present on the skeletal ridges between the papular regions, lacking armament on the papular regions. Modified from Marsh and Fromont (2020).

**Comments.** Gates and Rowe (1995) and Marsh and Fromont (2020) have listed the bathymetric range of this species as extending into the mesophotic, see also below.

Prey includes hard and soft corals, echinoids, encrusting sponges, ascidians, and algal biofilm on reef sand or seagrass substrates (Marsh and Fromont, 2020, Thomassin, 1976). Unusual population densities in the Maldives have had an adverse affect on corals recovering from bleaching events (Bruckner & Coward, 2018).

**Occurrence.** Primarily Western Indian Ocean, east Africa, including Madagascar, Maldives, to the Lakshadweep Islands, Indonesia, north-east coast of Australia, Western Australia to New Townsland and Cocos (Keeling) Islands. 0–92 m.

**Material examined.** USNM E37276 Off Lagoon, Kendikolu Island, Miladummadulu Atoll, Maldives, Indian Ocean. 5.97° N, 73.32° E, 44–46 m. Coll. F.C. Ziesenhenné. 29 March 1964. 1 dry spec. R=10.7, r=8.3.

MNHN-IE-2007-3995 North of Sainte Luce, southern Madagascar, 24° 35' 52.2024" S, 47° 32' 6" E, 80–86–m. Coll. ATIMO VATAE, R/V Nosy Be, May 2 2010. 1 wet spec.

### *Halityle* Fisher 1913

*Halityle* Fisher 1913: 211; 1919: 362

*Culcitaster* H.L. Clark 1914: 144

**Diagnosis.** Monotypic, as for species.

### *Halityle regularis* Fisher 1913

Figure 7a–g, Figure 8a–f

*Halityle regularis* Fisher 1913: 211; James 1973: 557; Baker and Marsh 1976: 107; Rowe and Gates 1995: 102; Branch et al. 2010: 224; Marsh and Fromont 2020: 422

*Culcitaster anamesus* H.L. Clark 1914: 145

**Diagnosis.** Specimens massive, bodies pentagonal to weakly stellate, thickened (R/r=1.18–1.66) with distinct lateral surfaces, abactinal surface with distinctive reticulate pattern. Body surface covered by continuous fine granular cover. Up to 22 superomarginals and 40–50 inferomarginals in each interradius. Actinal surface with distinct rhombic plates with strikingly dark-coloured regions around mouth. Adambulacral plates with furrow spines, 8–11, closely adpressed, flat. Two to three subambulacrals, domed, tips wrinkled. Modified from Baker and Marsh (1976).

Colour ranges from orange to red, maroon or purple with white, yellow to orange papular areas. Actinal surface apricot to pink with adjacent actinal plates orange or violet outlined with orange granules (modified from Marsh and Fromont, 2020). Exceptionally with white to yellow coloration extending over arm tips from actinal surface. Smaller individuals with more mottled variable colouration, with darker irregular plates around the periphery of the abactinal surface.

*Comments.* Although readily recognisable, relatively little is known about the biology and ecology of *H. regularis*. Numerous taxa are associated with this species, including parasitic cyclopoid copepods from Madagascar (Humes, 1971), the symbiotic shrimp and polychaete (*Periclimenes* and *Hololepidella*, respectively) in Vietnam (Antokhina and Kritayev, 2012), pontonine shrimp in Australia and New Caledonia (Bruce, 1980, 1983), and parasitic eulimid snails (Gosliner et al., 1996).

*Size changes in Halityle regularis.* Several if not all members of the Oreasteridae possess a dramatic shift in body morphology and colour as the individual develops from a relatively small to larger body size. This smaller size is similar to body forms observed in the Goniasteridae, with a more pentagonal to weakly stellate shape ( $R/r$  = approximately 1.0), as well as a more flattened abactinal surface with more weakly developed features, such as spines, granules, relative to the

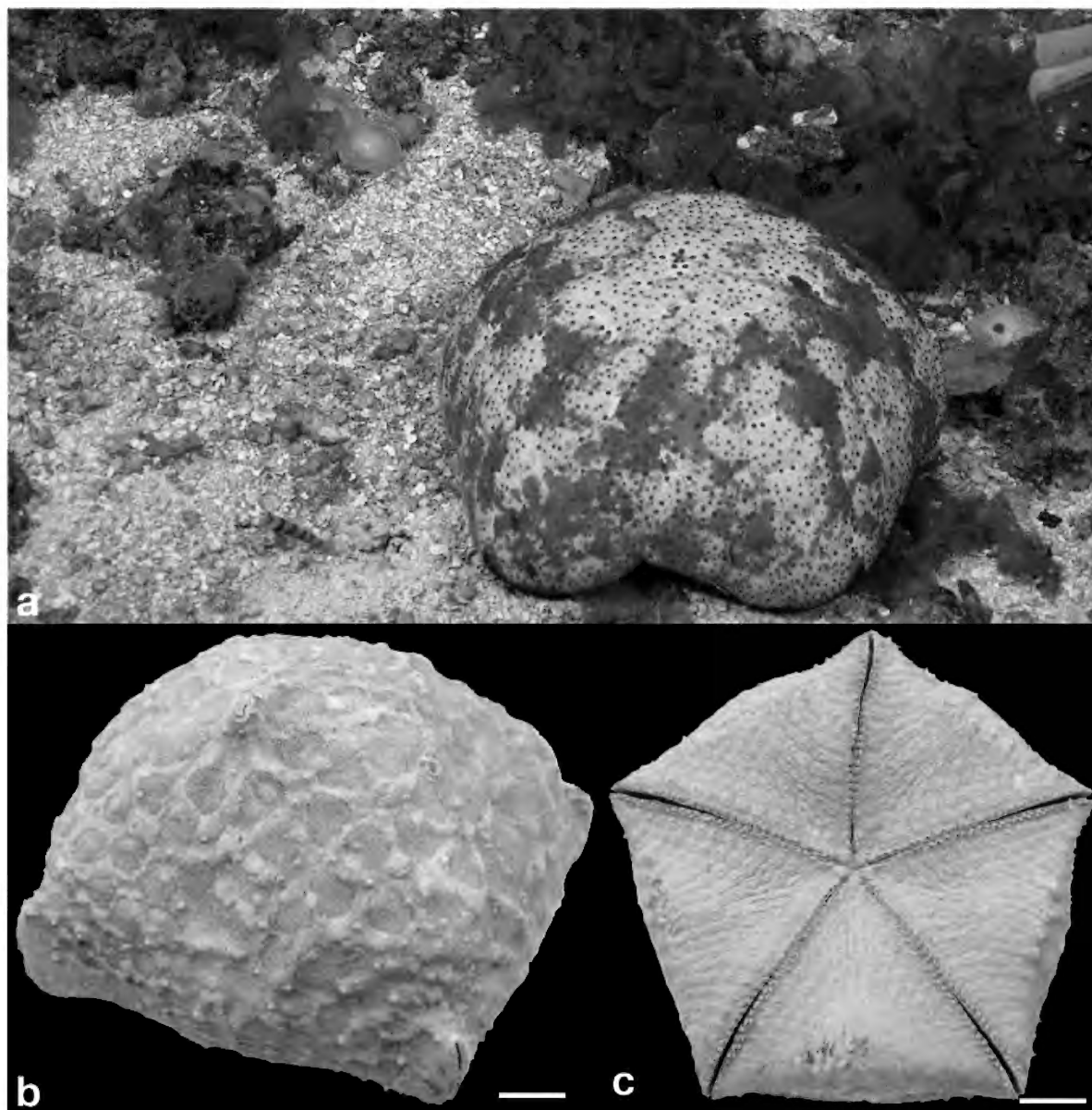


Figure 6. *Calcita* spp. a, *Calcita novaeguineae* in situ from Bowl Slide, Australia, 99 m. Courtesy of R/V *Falkor*, Schmidt Ocean Institute; b, *Calcita schmideliana*, USNM E37276, Abactinal view. Scale bar=2.0 cm; c, Actinal view. Scale bar=2.0 cm.

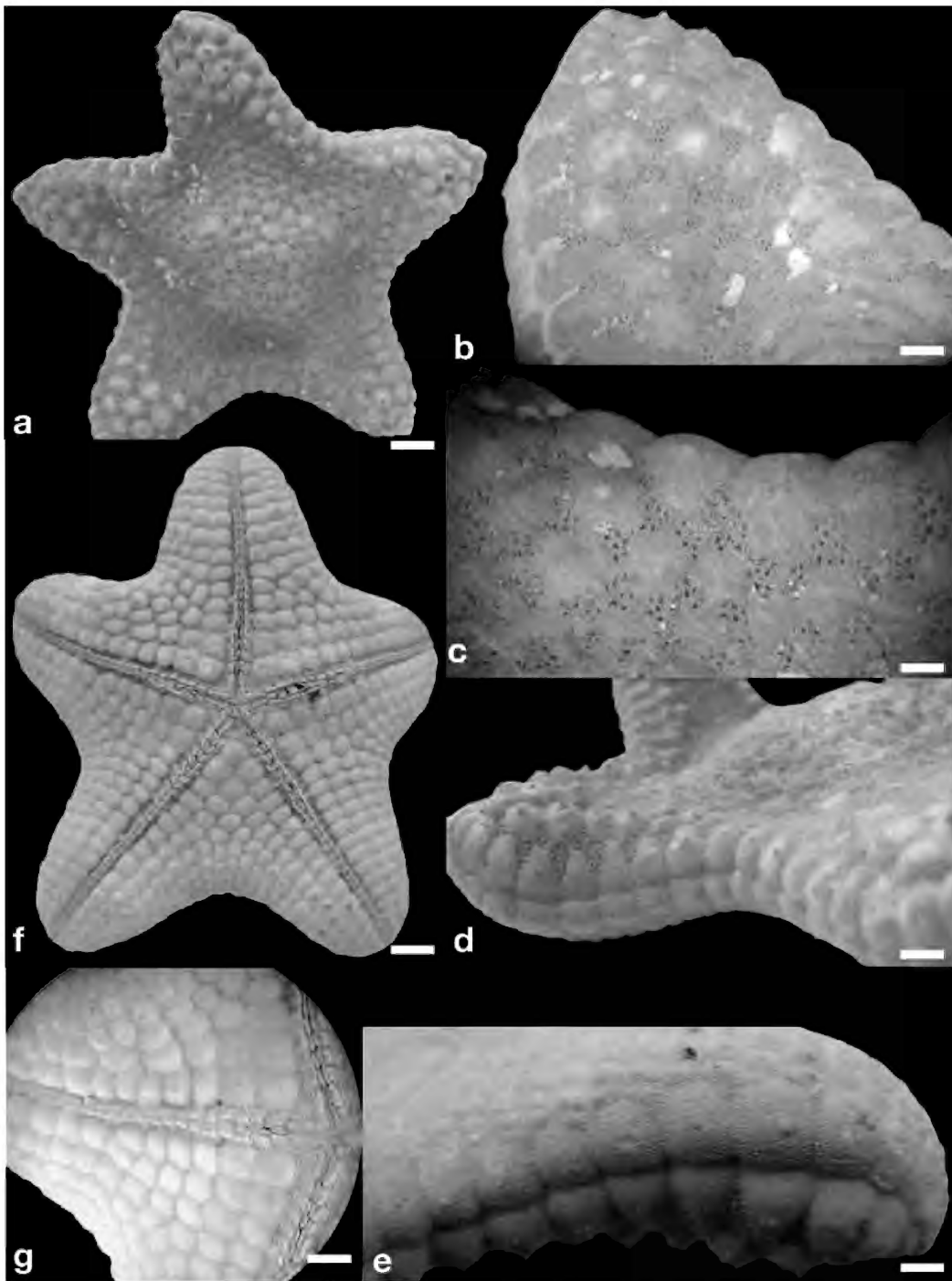


Figure 7. *Halityle regularis* USNM 1688944, Philippines, small individual. a, Abactinal view. Scale bar=0.5 cm; b, Close-up on arm tips showing enlarged distal and superomarginal plates. Scale bar=0.2 cm; c, Close-up on abactinal-superomarginal contact showing spiny tubercles on superomarginals. Scale bar=0.2 cm; d, Lateral view showing spiny tubercles and large spines on superomarginal, inferomarginal plates. Scale bar=0.2 cm; e, Inferomarginal and superomarginal plates. Scale bar=0.2 cm; f, Actinal view. Scale bar=0.5 cm; g, Closeup oral region, adambulacral furrow. Scale bar=0.2 cm.

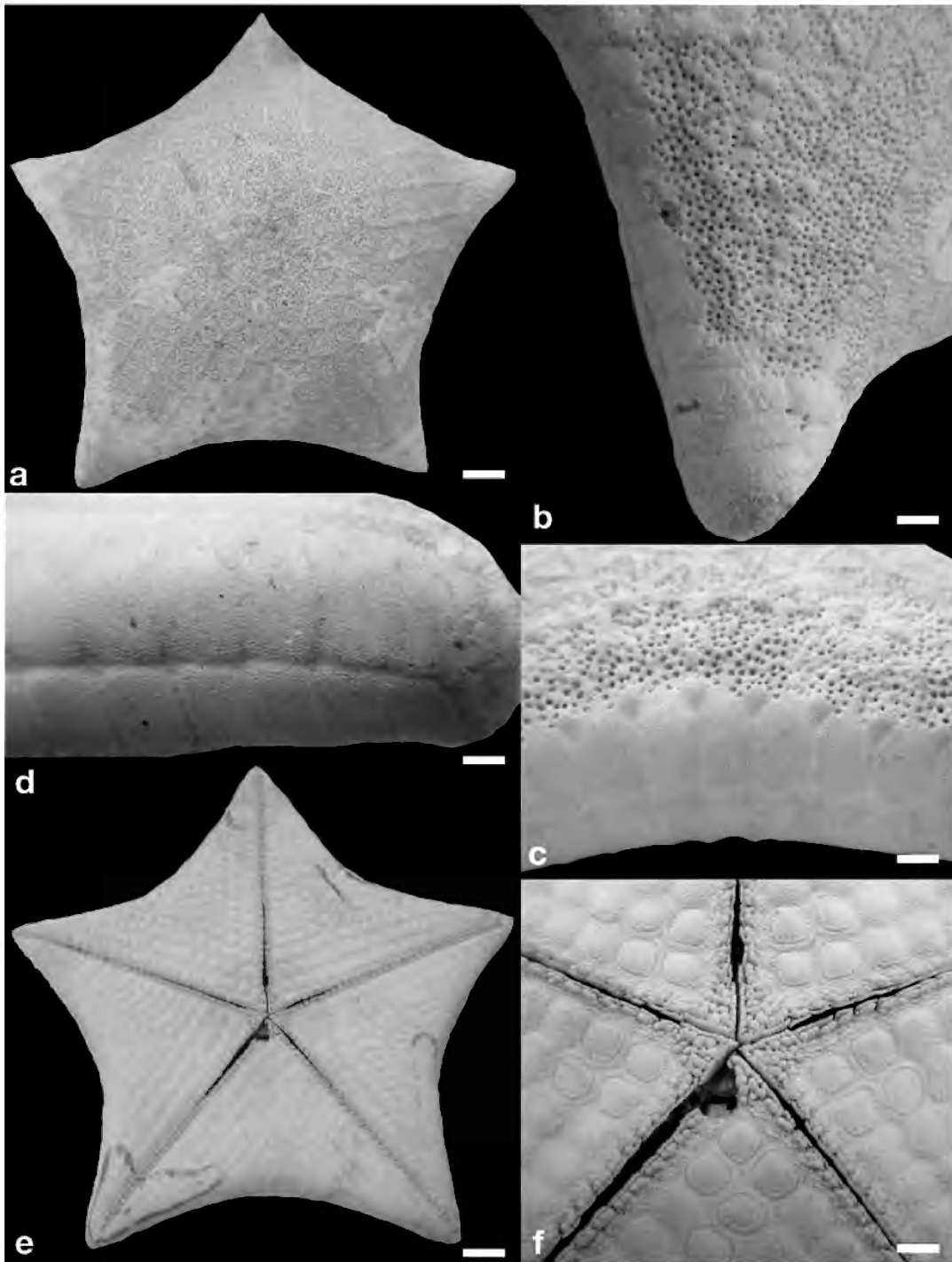


Figure 8. *Halityle regularis* USNM E45474, Somalia, larger individual. a, Abactinal view. Scale bar=1.5 cm; b, Closeup of arm tip showing low tubercles on distal surface. Scale bar=0.8 cm; c, Lateral view showing superomarginal plates and low tubercles. Scale bar=0.5 cm; d, Lateral view of arm tip showing marginal plates, inferomarginal, superomarginal surface. Scale bar=0.5 cm; e, Actinal view. Scale bar=1.5 cm; f, Closeup of oral and adambulacral furrow. Scale bar=0.5 cm.

strongly arched larger forms. This change has been observed most notably in *Culcita* species (Döderlein, 1917; Kano et al., 1991) whose adult form is relatively large and strongly arched (approximately 20–30 cm in diameter, 10–20 cm in height) relative to the smaller form (at approximately 0.5–4.0 cm), which is pentagonal in outline with a flattened abactinal surface, displaying few if any of the tubercles, spines or other characters observed in the larger forms. The differences were so pronounced that this smaller form was identified as a separate genus until intermediate sizes were recognised. Other oreasterids with documented changes of this kind include the tropical Atlantic *O. reticulatus*, which undergoes both a morphological but also colour change (Hendler et al., 1995) as it approaches a larger size. Although this morphological change is thought to be present throughout the Oreasteridae, size-related data across all genera remains incomplete, especially for those genera with more unusual, large-sized forms, such as *Halityle*.

USNM 1688944 is one of the smallest of reported *Halityle* specimens, and was compared with descriptions in Baker and Marsh (1976) as well as with other specimens at R=5.9, 9.1 and 13.0 cm. This specimen was recognised as *Halityle* based on its distinctive actinal plate pattern as well as the distinctive scalar granules covering the plate surface. It shares other recognisable features such as a consistent number of furrow spines, as well as the enlarged and identical number of subambulacral spines, the intercalated 22opular pores with the superomarginal plates, as well as the marginal plate shape. Nearly all the superomarginal plates, as well as numerous enlarged, strongly convex abactinal plates present on the distal surface of the arm, display pronounced tubercles or short, pointed spines. Inferomarginals also display 1–4 enlarged round tubercles or spines centrally on the plate surface.

Numerous differences between USNM 168894 and the other, larger specimens are apparent. Note, however, that individuals from different areas may also show variation in morphological character development as they increase in size. Perhaps the most distinct difference is the presence of tubercles with spiny tips on distalmost abactinal and superomarginal plates. Tubercles/spines seem to be, at first, distinctly at odds with the morphology of adult specimens, because nearly every detailed description of *H. regularis* notes the complete absence of spines or similar accessories on the abactinal and marginal plate surfaces. However, careful examination of the sequentially larger specimens, USNM E45474 with R=9.1 and USNM E13719, R=5.9, 6.4, shows very small, low, mound-like tubercles present in the distal and lateral regions on the disk and arms, sitting on the plates between the papular areas. These tubercles appear lower and broader as the animal becomes larger among the Somalian specimens studied herein. Among the larger specimens available (USNM 40867, no data) and the holotype (USNM 32634, which have R>13.0 cm, there appear to be minute, weakly expressed rugosities in these areas. This implies that these more acutely pointed tubercles are covered over by the granular cover or the plates are expanded as the animal grows. Prior accounts, such as Fisher (1919), have not mentioned these rugose projections, likely owing to their small size and

relatively nondescript appearance consistent with the granular surface. The spine-like tubercles on the superomarginal plates appear to be displaced to a location above the contact between superomarginal plates in each interradius. Curiously, although abactinal and superomarginal tubercle/spines appear to be compensated for on larger specimens, these structures do not show relictual presence on the inferomarginal plates.

Pedicellariae were not observed in USNM 1688944 but are present in specimens with R>5.9 on the adambulacral plates, with descriptions mentioning further pedicellariae in large specimens, suggesting they emerge in larger individuals. Papular regions show an increase in the number of papular pores between the specimen showing R=4.5 and r=5.9. These areas become more triangular and better developed in larger individuals. The substantial changes to body shape occur between R=4.5 and R=5.9: the disk begins developing the strong arched convex shape, arms become more lateral facing, and the reticulate pattern in the adult forms takes on its more distinct appearance.

USNM 1688944 is otherwise consistent with prior descriptions of this species (Baker and Marsh, 1976). This includes a similar granular covering, rhombic actinal plates, a consistent number of furrow spines (8–11), domed subambulacral spines (two to three), and identical pedicellariae.

**Occurrence.** Widely distributed throughout the Indo-Pacific. Southern Japan, Enewetak Atoll, New Caledonia, the Philippines, Lembeh Strait, Indonesia, Vietnam, the Lakshadweep Archipelago, southern India, east Africa, Madagascar; Ningaloo Reef, Exmouth Gulf, North West Shelf, Western Australia; Keppel Bay and Heron Island, Queensland. 3–275 m.

**Material examined.** USNM E13719 SW of Gas Jinnah, Somalia, Indian Ocean. 9.68° N, 51.05° E, 60–70 m. Coll. R/V *Anton Bruun*, 16 Dec 1964. 2 dry specs. R=5.9, r=3.7; R=6.4 r=3.9.

USNM E45470 Off NE coast, Somalia, Indian Ocean. 10.3843° N, 51.2517° E, 26–37 m. Coll. R/V *Anton Bruun*, 8 Jan 1987.1 dry spec. R=13.0 r=8.0.

USNM E45474 Off NE coast, Somalia, Indian Ocean. 10.3843° N, 51.2517° E, 40–49 m. Coll. R/V *Anton Bruun*, 8 Feb 1987. 1 dry spec. R=9.1, r=5.5.

USNM 168894 Balut Island, Philippines, North Pacific Ocean. 50–150 m. 1 dry spec. R=4.5, r=2.5.

### ***Pentaceraster Döderlein, 1916***

Döderlein, 1916: 424; 1936: 331; Clark and Rowe 1971: 55; A.M. Clark 1993: 310 (checklist)

**Diagnosis.** Body stellate (R/r=2.0–3.0, seldom >3.0) with strongly arched disk, elongate, triangular arms. Distal abactinal, actinal and especially marginal plates covered with distinct, even-sized, projecting granules. Abactinal–lateral regions with distinctly reticulate plates showing well-defined pore areas. Primary plates with spines or conical tubercles arranged in longitudinal series in most species. Distal inferomarginal plates with an enlarged spine or conical projection in most species. Intermarginal pore areas weakly developed or absent. Modified from Marsh and Fromont (2020).

**Comments.** *Pentaceraster* includes 15 species that occur widely throughout the Indo-Pacific. The diagnosis follows Marsh and Fromont (2020), but boundaries for the concept of *Pentaceraster* have not been tested or reviewed since their establishment (Döderlein, 1916, 1936). Other oreasterid genera, such as *Poraster*, and the typological *Oreaster*, differ from *Pentaceraster* by relatively few characters and invite additional scrutiny, especially as further data on variation among species within these genera has produced taxonomic overlap. For example, Döderlein's key (1936) differentiates the Atlantic *Oreaster* from *Pentaceraster* by the presence of low dorsal spines, a character observed in highly variable Indo-Pacific species, such as *Pentaceraster alveolatus* or *Pentaceraster mammilatus*. Character variation among *Pentaceraster* species is similarly problematic, with several species displaying character variation that is at odds with established species concepts, particularly as outlined by Döderlein (1916, 1936).

### *Pentaceraster alveolatus* (Perrier 1875)

Figure 9a–f

*Pentaceros* Perrier 1875: 243 (1876: 59); Koehler 1910: 95

*Oreaster* Bell 1884: 73; Domantay and Roxas 1938: 212

*Pentaceraster* Döderlein, 1916: 428; Jangoux 1986: 126; Kohtsuka et al. 2020: 58

**Diagnosis.** Primary circlet and carinal series bearing large, conical spines, dorsolateral armament present primarily on the disk. Superomarginals and inferomarginals with prominent spines. Spination on disk and arms variably absent to abundant with lateral regions on disk and arms. Arms slender and elongate. Based on Marsh and Fromont (2020), Clark and Rowe (1970).

**Comments.** *Pentaceraster alveolatus* is a widely occurring and highly variable species, which apparently displays a significant amount of morphological overlap with other *Pentaceraster* species within its range. Although an identification has been made with the surest possible accounting, boundaries for differing species and variation observed in the specimens themselves present difficulty. Identification was based on the relatively few spines present along dorsal surfaces along the disk and arms, as outlined by Clark and Rowe (1970), but variation is inconsistent with published taxonomic definitions, as are other instances outlined herein. Revision is desirable.

USNM E37286 is most similar to a large specimen (R=13 cm) figured by Döderlein (1936: Fig. XXV, Figs. 2 & 3) identified as *P. alveolatus*, from the Philippines, showing pronounced spination on the lateral sides of the disk but more weakly on the mid to distal arm regions. However, Döderlein (1936) shows a wide range of spine expression for *P. alveolatus* from the Philippines to southern Japan, including several individuals with much less spinose abactinal surface and starkly different appearance.

USNM E37286 also shows one to few spines on the superomarginal plates of each interradius, which conflicts with the diagnostic keys in Clark and Rowe (1971). This result

would suggest *Pentaceraster horridus* or *Pentaceraster tuberculatus*. Neither of these species concepts as outlined by Döderlein (1936) appears consistent with USNM E37286.

If correctly identified, USNM E37286 represents the first occurrence of this species from the African coast and one of the few records of this species from the Indian Ocean. Marsh and Fromont (2020) reported one specimen of this species from Western Australia, from 35 m depth. It is possible that this species only occurs at mesophotic depths in the Indian Ocean. If so, the morphology could be phenotypically variable owing to depth or indicative of a cryptic species.

**Occurrence.** Widely occurring throughout the Indo-Pacific. Southern Japan, China, Guam, New Caledonia, Samoa, Indonesia, Philippines, Western Australia (single occurrence), 1–54 m.

**Range & depth extension.** Somalia, 60–70 m.

**Material examined.** USNM E37286 SW of Gas Jinnah, Somalia, Indian Ocean. 9.68° N, 51.05° E, 60–70 m. Coll. R/V Anton Bruun, 16 Dec. 1964. 1 dry spec. R=12.1, r=3.9.

### *Poraster* Döderlein, 1916

Döderlein, 1916: 438; 1936: 364.

**Diagnosis.** Body strongly stellate (R/r=2.7–4.5), disk thick, arms elongate, tapering. Adult sizes approximately R=24.0–30.0 cm. Abactinal surface coarsely granulated, lacking primary accessories (i.e. spines, tubercles) save for a prominent row of large, conical tubercles present along the carinal series of each arm. Well-defined, interradian, intramarginal region present, spanning approximately 10–16 supero-inferomarginal plate pairs. Spine-bearing plates present, transversely bisecting the contacts between the marginal plate pairs intramarginally. Furrow spines 5–7, subambulacral spines three to four. Papulae confluent on abactinal surface and present intermarginally but absent from the actinal surface (modified from ; Döderlein, 1916; Marsh and Fromont, 2020).

### *Poraster superbus* (Möbius, 1859)

Figure 10a–e

*Oreaster superbus* Möbius, 1859: 5; Bell 1884: 81.

*Oreaster productus* Bell 1884: 74

*Pentaceros superbus* Sladen 1889: 345; Simpson and Brown 1910: 51; Brown 1910: 33.

*Pentaceros indicus* Koehler 1910: 110.

*Poraster productus* Döderlein, 1916: 438

*Poraster superbus* Döderlein, 1916: 440; 1936: 364; Humes and Cressey 1958: 395; Clark and Rowe 1971: 34, 54; Bruce 1974: 485; Jangoux 1984: 280; A.M. Clark 1993: 317 (checklist with synonymies); Kogure and Igei 2013: 33; Marsh and Fromont 2020: 432

*Poraster superbus* var. *bengalensis* Döderlein, 1936: 367

**Diagnosis.** Monotypic, as for genus.

**Comments.** Occurrences of *P. superbus* have been observed from Madagascar indirectly, primarily from records of various parasitic and associated crustacean species (e.g. Humes and Cressey, 1958; Bruce, 1974). Uncertainty was reflected by Clark and Rowe (1971), who qualified its occurrence in

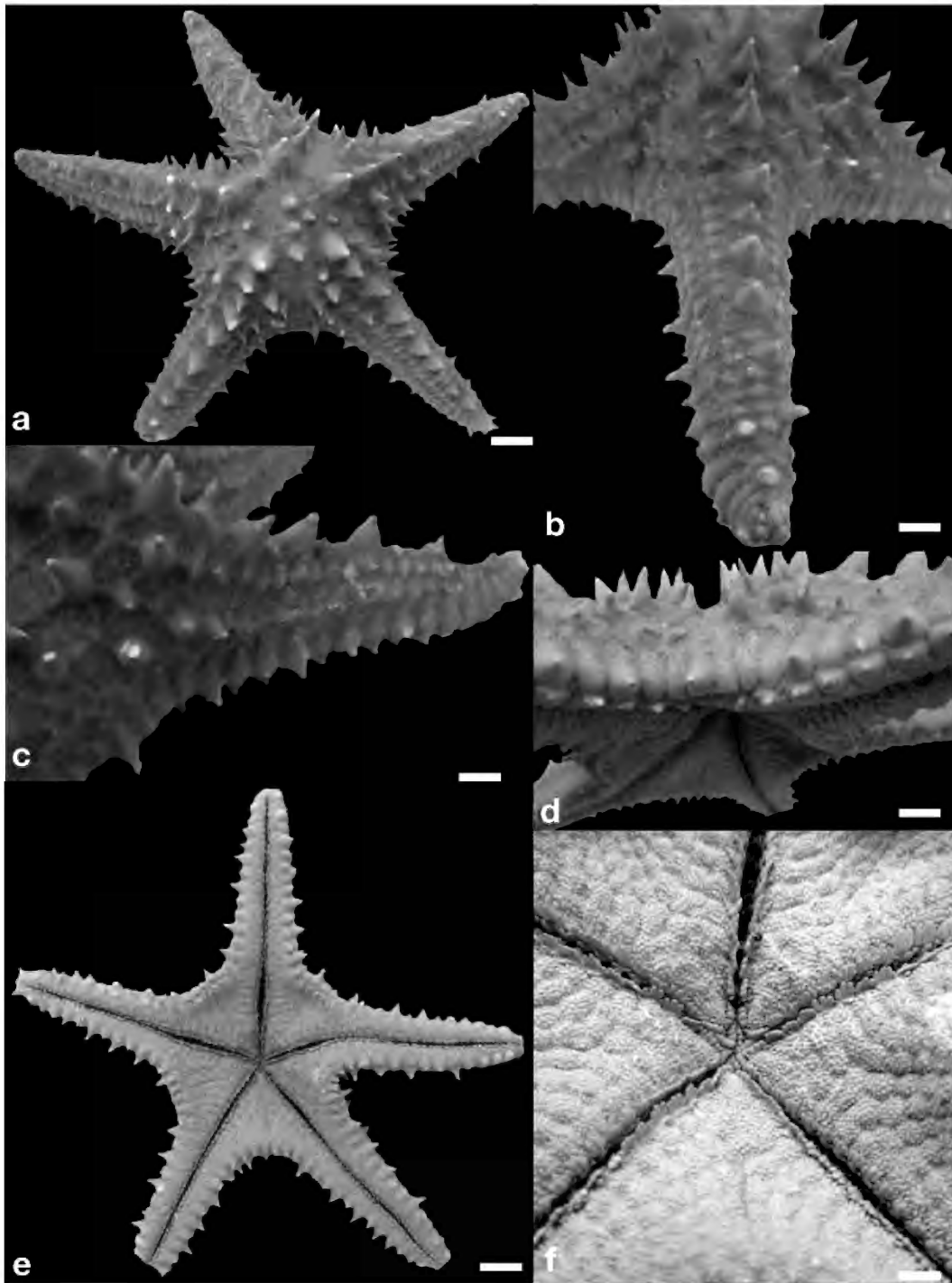


Figure 9. *Pentaceraster alveolatus* USNM E37286 a, Abactinal view. Scale bar=2.0 cm; b, Abactinal-lateral view showing degree of spination along arm. Scale bar=0.5 cm; c, Abactinal-lateral view showing spination and superomarginal surface. Scale bar=0.5 cm; d, Actinal-lateral view showing marginal spination. Scale bar=0.5 cm; e, Actinal view. Scale bar=2.0 cm; f, Closeup of oral region and ambulacral spination. Scale bar=0.5 cm.

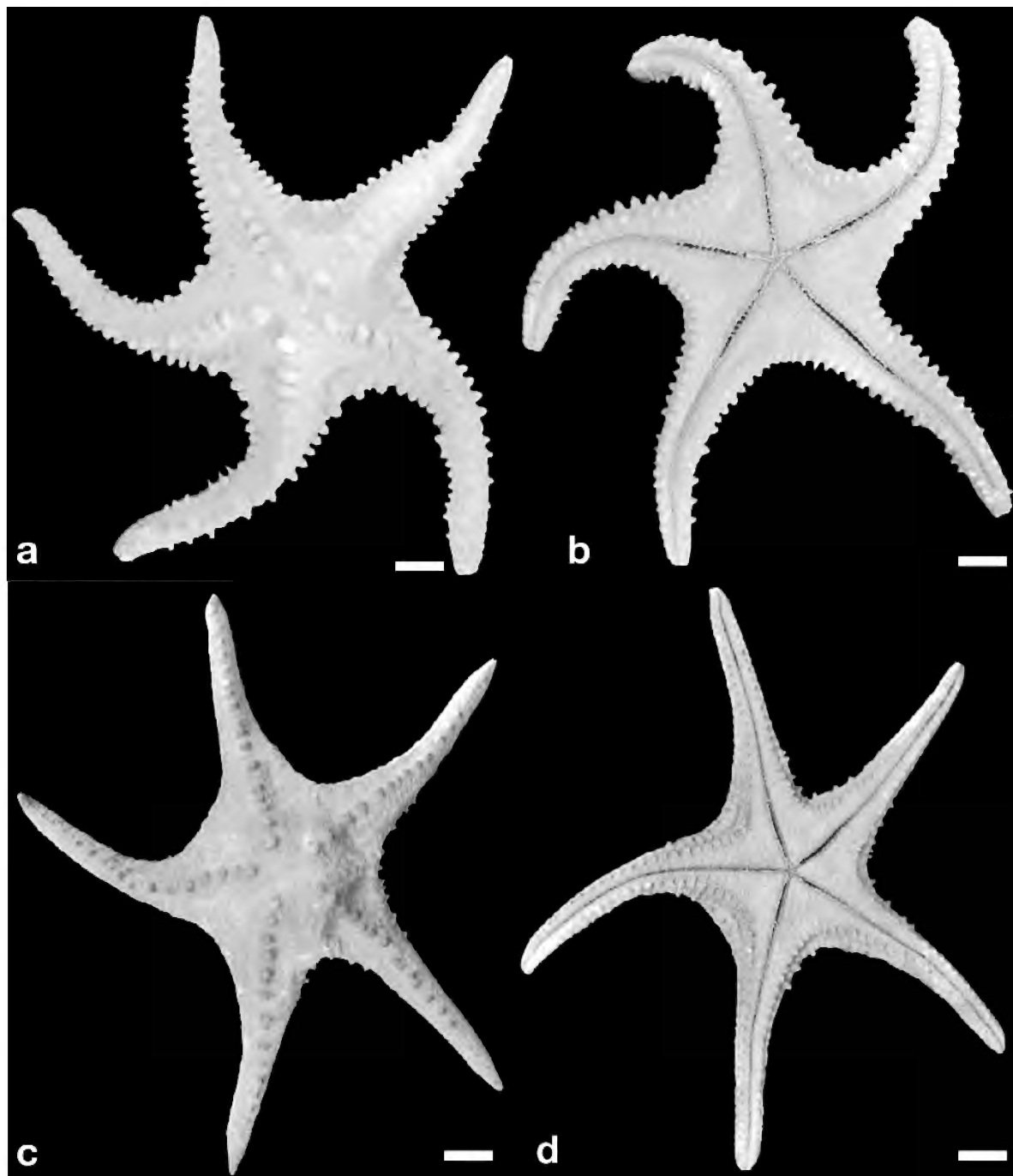


Figure 10. *Poraster superbus* variation. All scale bars=1.5 cm. a, USNM E45289 Abactinal; b, Actinal; c, USNM E 47401, Abactinal; d, Actinal.



Madagascar and east Africa with a “?”, as well as by Marsh and Fromont (2020), who listed the species as present on the north-east coast of Africa but not further south. Multiple specimen records as well as imagery from iNaturalist confirm its presence in the Madagascar region.

Most recent accounts of *Poraster* reflect a single, wide-ranging species, *P. superbus*. The synonymy, however, reflects at least four morphotypes throughout its range. Two of those species, *P. superbus* var. *benegalensis* Döderlein, 1936 and *Poraster productus* (Bell, 1884) display small abactinal and carinal tubercles/spination compared to *Poraster indicus* (Koehler, 1910) and *P. superbus* itself. These latter two variants are apparently distinguished by the extent of superomarginal spination. Of the specimens examined, E47401 is more consistent with the *indicus* variant, whereas E45289 is more consistent with the description by Möbius (1859).

Few data are available on the biology of *P. superbus*. This species has been reported feeding on shelly sand with its stomach everted on a sand-encased solitary ascidian, as well as scavenging on moribund echinoids (Marsh and Fromont, 2020). Several parasitic and associated crustacean species have been reported (e.g. Humes and Cressey, 1958; Bruce, 1974). One observation (Derleisereiter, 2020) shows an individual in a spawning position with arms suspending the disk into the water column above a sandy substrate.

**Occurrence.** North-east coast of Africa to Zanzibar. Bay of Bengal to New Caledonia, southern China and north to Japan. 20–55 m. iNaturalist observations also show this species in Sri Lanka (Laccadive Sea), Singapore and in the Seychelles.

**New records.** Madagascar, Mozambique Channel, 30 m. Tanzania, Mergui Archipelago, Burma, Andaman Sea to 96 m (new depth record).

**Material examined.** USNM E 45289 Mozambique Channel, Madagascar, Indian Ocean, -15.87° S, 44.38° E, 30 m. Coll. R/V *Anton Bruun*, International Indian Ocean Expedition, 19 Oct 1964. 1 dry spec. R=16.2 cm, r=4.7.

USNM E 47401 Lord Loughborough Island, Mergui Archipelago, Andaman Sea, Burma. 10.62° N, 97.57° E, 96 m. Coll. R/V *Anton Bruun*, International Indian Ocean Expedition, 24 March 1963. 1 dry spec. R=21.4, r=6.5.

USNM E47402 East of Phuket Island, Thailand, Andaman Sea, Indian Ocean. 7.92347° N, 98.8363° E, 16–20 m. Coll. RV *Gallardo*, Fifth Thai Danish Expedition, 15 Feb 1966. 2 dry specs. R=20.0 r=5.0; R=22.0 r=4.8.

CASIZ 30883 South Tanzania, Menai Bay, -6.408° S, 39.4106667° E, 18 m. Coll. Coral Reef Research Foundation, 3 Feb 1996. 1 wet spec.

MNHN-IE-2007-1000, South of Cape Saint Sebastian, Madagascar, Indian Ocean. -12.61717° S, 48.505° E, 59–60 m. Coll. Bouchet, Puillandre and Richer, MIRIKY. 29 June 2009. 1 wet spec. R=14.4, r=5.2.

MNHN-IE-2007-1090, South of Cape Saint Sebastian, Madagascar, Indian Ocean. -12.62733° S, 48.43317° E, 60–63 m. Coll. Bouchet, Puillandre and Richer, MIRIKY. 29 June 2009. 2 wet specs. R=4.3, r=1.2; R=1.3, r=0.6.

## *Protoreaster* Döderlein, 1916

### *Protoreaster lincki* (de Blainville, 1830)

Figure 11a–e

*Asterias lincki* de Blainville 1830: 238; 1834: 219

*Pentaceros muricatus* Gray 1840: 277

*Oreaster muricatus* Dujardin and Hupe 1862: 383

*Oreaster reinhardti* Lütken 1864: 159; Bell 1884: 74.

*Oreaster lincki* Lütken 1864: 156; Bell 1884: 72; H.L. Clark 1923: 273.

*Pentaceros reinhardti* Perrier 1878: 24; Sluiter 1895: 56; Koehler 1910: 101.

*Protoreaster lincki* Döderlein 1916: 423; 1936: 328; Tortonese 1949: 33; Kalk 1954: 113; Macnae and Kalk 1962: 108; Balinsky 1958: 1969; Kalk 1958: 215; 1959: 21; Day 1969: 182; A.M. Clark and Rowe 1971: 54; Jangoux 1973: 23; A.M. Clark and Courtman-Stock 1976: 68; Julka and Das 1978: 346; Marsh 1976: 222; Sloan et al. 1979: 722; Ebert 1979: 72; Tortonese 1980: 11; Aziz and Jangoux 1984: 137; A.M. Clark 1984: 90; Jangoux and Aziz 1984: 860; Walenkamp 1990: 51; Aziz 1986: 323; Marsh and Fromont 2020: 435.

**Diagnosis.** Body strongly stellate (R/r=2.3–3.0), arms triangular in shape, disk and arms thick, strongly arched, triangular in cross-section. Surface covered by smooth pavement of flat, polygonal granules. Primary circlet on disk with prominent spines, this area divided into five triangular regions. Reticulation across abactinal surface with well-developed reticulation surrounding areas with numerous papular pores, including five triangular regions on disk. Distal superomarginal plates with prominent laterally projecting tapering spines or knobs. Inferomarginal spines/tubercles absent. Bivalve pedicellariae present on a minority of marginal plates. Modified from Marsh and Fromont (2020).

**Comments.** Although recognised primarily as a near-shore, shallow-water species, previously documented at 0–10 m depth (Marsh and Fromont, 2020), one specimen collected from Madagascar was recorded from 40 m, a mesophotic and currently the deepest-known occurrence.

Marsh and Fromont (2020) indicated that it feeds on microbial biofilms and opportunistic scavenging. Ebert (1976) reported this species spawning in the Seychelles in early May and in northwestern Australia during November.

Shrimp associates such as *Zenopontonia* (formerly *Periclimenes*) have been observed in association with this species (Bruce, 1982).

**Occurrence.** Western Indian Ocean. Red Sea, Sri Lanka, Mozambique, Java, Indonesia. Northwest Australia, 0–40 m.

**Material examined.** IE-2007-3947, Madagascar, 25° 45.7' N, 44° 52.0' E. 41.0 m. Coll. N/O *Nosy Be*, 13 May 2010. 1 wet spec. R=8.8, r=3.3.

**Discussion.** The Oreasteridae surveyed herein as well as many other asteroid species in the Indo-Pacific region (e.g. Mah, 2017, 2018, 2021) are present at much deeper depths than recorded previously (e.g. 0–10 m for *P. lincki* [Marsh and Fromont, 2020] versus 40 m herein). The oreasterids surveyed here are widespread, ranging from the Indian Ocean (e.g. *P.*

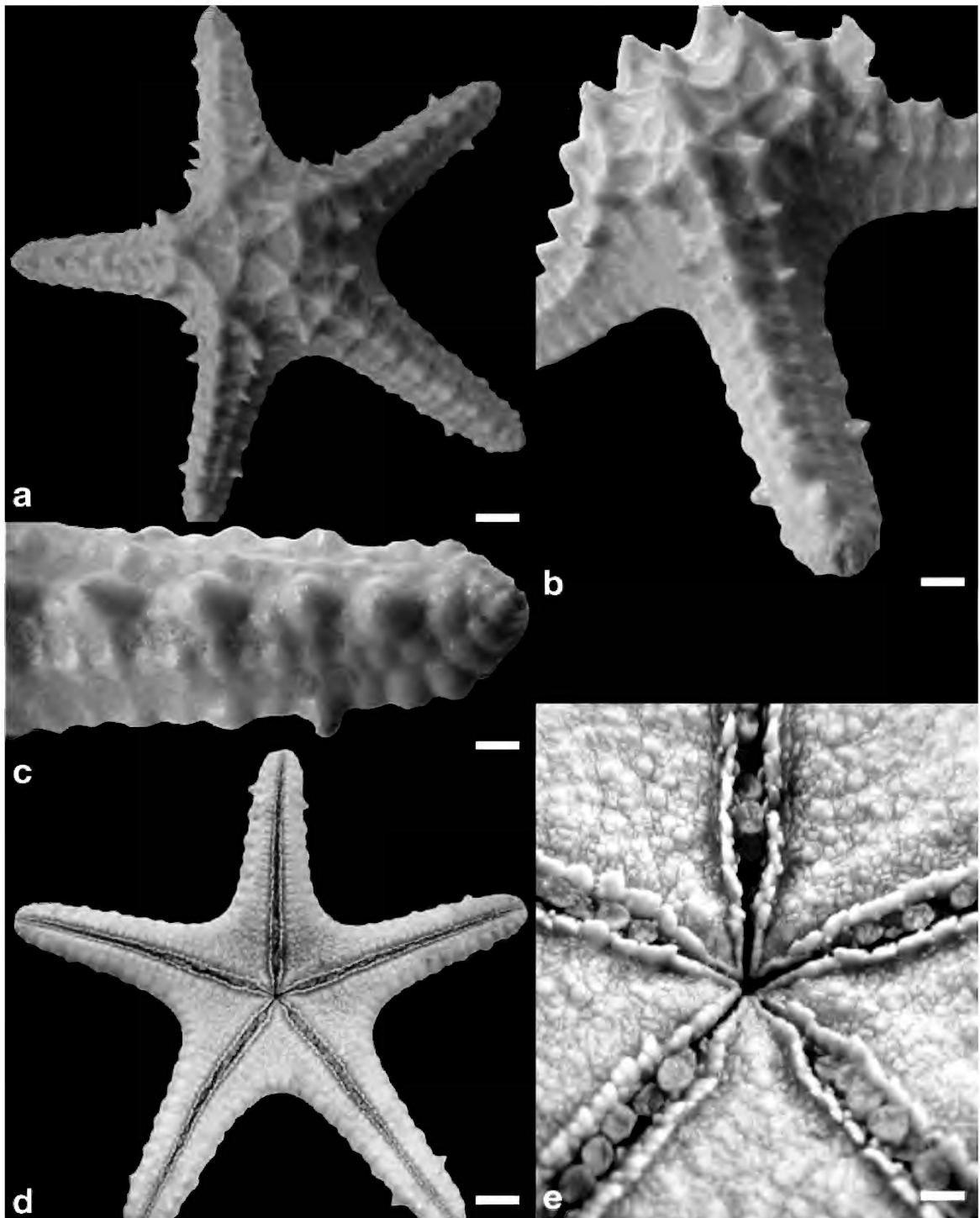


Figure 11. *Protoreaster lincki*. MNHN IE-2007-3947. a, Abactinal view. Scale bar=1.5 cm; b, Abactinal-lateral view showing degree of spination and disk and arms. Scale bar=0.5 cm; c, Armtip showing carinal and superomarginal spines. Scale bar=1.0 cm; d, Actinal view. Scale bar=1.5 cm; e, Closeup of oral region and adambulacral spination. Scale bar=0.5 cm.

*lincki* or *C. schmideliana*) to throughout the Indo-Pacific (e.g. *A. idipi*, *P. alveolatus*). This combination of widespread distribution and extending into the mesophotic is a trend observed in other shallow-water tropical asteroid Valvatida, such as in the Goniasteridae (e.g. *Fromia*), the Ophiasteridae (e.g. *Linckia*) and the Asterodiscidae (e.g. *Asterodiscides*) (Mah, 2021). Distributions of these taxa remain largely shallow (< 200 m), with only some taxa exceptionally extending much deeper (e.g. *Asterodiscides* can occur to 800 m).

Most oreasterids surveyed here appear to be extensions of shallow-water asteroid faunas, that is, species displaying a wide bathymetric range, a pattern also observed in other taxa, such as corals and fishes (Kahng et al., 2016). Food may be one important consideration, as numerous accounts have observed the widespread presence of benthic communities dominated by algae, sponges, cnidarians and other encrusting or colonial organisms (e.g. Harris et al., 2021; Bell et al., 2022). Observations of shallow-water oreasterid taxa, including *C. granulatus*, *Protoreaster*, and *Culcita* spp. have indicated food preferences consistent with bottom fauna observed at these depths, particularly sponges and microalgal biofilms, all of which appear to be tied to the lower limit of photosynthesis.

*Astrosarkus* (Fig. 2a–d, 3a–b) has been observed in close proximity to multiple sessile taxa, including cnidarians and sponges (Fig. 3a).

Bathymetrically, *Astrosarkus* stands apart in occurring at greater depths (67–210 m) than other mesophotic Oreasteridae (0–100 m, only exceptionally to 275 m). The most prominent feature that sets *Astrosarkus* apart from other oreasterids is its thick, soft body wall, which is unique within the Oreasteridae. Members of the family Poraniidae display a similar type of strongly developed soft-tissue body wall (Mah and Foltz, 2014). This character is poorly understood, but all living poraniids are known from cold-water settings (Mah and Blake, 2012) suggesting that this character could be constrained or influenced by colder-water habitats. *Astrosarkus*' unusual body wall could be influenced by its depth, because the mesophotic zone is cooler than shallow tropical settings in the 0–100 m zone.

Based on the taxa surveyed herein, oreasterids appear similar to other mesophotic faunas (e.g. fishes, sponges, gorgonians; Baldwin et al., 2018; Idan et al., 2018, respectively) in being a mix of shallow-water taxa with a minority of taxa, in this case *Astrosarkus* spp., that are limited to a mesophotic distribution (Breedy and Guzman, 2013). Other asteroid groups, including the Ophiasteridae, Goniasteridae, and Asterodiscidae, with similar mesophotic distributions (i.e. they do not occur in shallow, surface-level habitats), have been reported from the South Pacific (Mah, 2021). As further taxonomic groups are surveyed, it is hoped that better understanding of mesophotic species will provide a stronger basis for understanding diversity and establishing marine conservation in this setting.

## List of mesophotic Oreasteridae treated here

*Astrosarkus idipi* Mah 2003

*Astrosarkus lu n. sp.*

*Culcita novaeguineae* Müller and Troschel, 1842

*Culcita schmideliana* (Bruzeliuss, 1805)

*Halityle regularis* Fisher, 1913

*Pentaceraster alveolatus* (Perrier, 1875)

*Poraster regularis* (Möbius, 1859)

*Protoreaster lincki* (de Blainville, 1830)

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## New records, one new genus and 21 new species of Callianassidae (Crustacea, Axiidea) from the Indo-West Pacific

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### Abstract

Poore, G.C.B. 2023. New records, one new genus and 21 new species of Callianassidae (Crustacea, Axiidea) from the Indo-West Pacific. *Memoirs of Museum Victoria* 82: 167–255.

The collections of ghost shrimps from the Indo-West Pacific that contributed to recent molecular phylogeny and resulting reclassification of Callianassidae (Poore et al., 2019; Robles et al., 2020) provide opportunities to review 11 genera and describe one new genus, redescribe existing species and describe 21 new species. *Aqaballianassa aqabaensis* (Dworschak, 2003), *A. brevirostris* (Sakai, 2002), *A. lewtonae* (Ngoc-Ho, 1994) are rediagnosed and *Aqaballianassa papua* sp. nov. from Papua New Guinea and *Aqaballianassa seychellensis* sp. nov. from the Seychelles are described as new. Three new species of *Caviallianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 are compared in a key with *Caviallianassa cavifrons* (Komai and Fujiwara, 2012): *Caviallianassa arafura* sp. nov. from the Arafura Sea, *Caviallianassa riwo* sp. nov. from Papua New Guinea and *Caviallianassa moorea* sp. nov. from French Polynesia. *Callianassa thailandica* Sakai, 2005 is treated as species inquirenda. No species of *Cheramus* Bate, 1888 occurs in the Indo-West Pacific despite the genus name having been widely used. Five species of *Coriollianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 are recognised and figured: *C. sibogae* (De Man, 1905), *C. coriolisae* (Ngoc-Ho, 2014) and new species, *Coriollianassa mainbazeae* sp. nov. and *Coriollianassa maputo* sp. nov. from the Mozambique Channel, and *Coriollianassa nynggulu* sp. nov. from the North West Australian slope. *Darryllianassa felderi* gen. et sp. nov. is described from Papua New Guinea. *Necallianassa nosybeensis* sp. nov. is described as a new species from Madagascar. *Praedatrypaea* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 is rediagnosed. Thirteen species are recognised and most diagnosed; four species are described as new: *Praedatrypaea jangamo* sp. nov. and *Praedatrypaea mozambiquensis* sp. nov. from Mozambique, and *Praedatrypaea mandu* sp. nov. and *Praedatrypaea ningaloo* sp. nov. from the North West Shelf of Australia. *Callianassa malaccaensis* Sakai, 2002 is treated as a junior synonym of *P. orientalis* (Bate, 1888). A key to separate ten species of *Praedatrypaea* is presented. *Pugnatrypaea* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 is rediagnosed and confined to three species. *Rayllianassa* Komai and Tachikawa, 2008 is rediagnosed and its species discussed. *Rayllianassa amboinensis* (De Man, 1888), a variable species, is rediagnosed; *Callianassa ngochoae* Sakai, 1999 and *Callianassa sahu* Poore, 2008 are treated as synonyms. *Rayllianassa aurora* sp. nov., *Rayllianassa bifida* sp. nov. and *Rayllianassa huonensis* sp. nov. are described as new species; the first two are associated with submerged wood at depths greater than 100 m. *Rudisullianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 is rediagnosed. *Rudisullianassa rudisulcus* Komai, Fujita and Maenosono, 2014 is discussed and partially illustrated; *Rudisullianassa pandan* sp. nov. is described as a new species from submerged wood. *Spinicallianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 is reviewed and a key is provided to five species; three species are described as new: *Spinicallianassa bilbili* sp. nov. from Papua New Guinea; *Spinicallianassa papetoi* sp. nov. from French Polynesia; and *Spinicallianassa westralia* sp. nov. from Western Australia. *Callianassa parvula* Sakai, 1988 is treated as a possible synonym of *S. spinicauda* (Komai, Maenosono and Fujita, 2014). *Trypaea* Dana, 1852 contains only *T. australiensis* Dana, 1852 and does not occur in the Indo-West Pacific as sometimes reported.

**Keywords** ghost shrimps, taxonomy, new genus, new species, rediagnoses

### Introduction

The family name Callianassidae Dana, 1852 was once used to describe a wide range of burrowing ghost shrimps belonging to the infraorder Axiidea de Saint Laurent, 1979. It has been progressively restricted and is now just one of eight similar families (Poore et al., 2019). Poore et al.'s (2019) revision and

the molecular phylogeny on which it was based (Robles et al., 2020) depended in part on extensive collections made in the Indo-West Pacific over the last couple of decades. These collections also made it possible to rediagnose known species and describe others revealed as new during the molecular study. This paper follows earlier contributions on Eucalliidae Manning and Felder, 1991 (Poore, 2021),

Callichiridae Manning and Felder, 1991 (Poore, 2023), and the callianassid genera *Scallasis* Bate, 1888 (Komai et al., 2020) and *Arenallianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 (Schnabel et al., 2023).

Callianassidae comprise 26 genera, diagnosed by Poore et al. (2019), and 114 extant species (DecaNet eds, 2023). This contribution deals only with those from coral reefs and shelf environments in the Indo-West Pacific and northern Australia. Twelve genera, one newly diagnosed, and 39 species are covered here, of which 21 species are described as new. *Jocullianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019, *Paratrypaea* Komai and Tachikawa, 2008 and further comments on *Scallasis* are kept for other contributions.

## Methods

Much of the material comes from the Muséum nationale d'Histoire naturelle, Paris (MNHN), including expeditions to Papua New Guinea, Madang Province (PAPUA NIUGINI stations) and New Ireland Province (KAVIENG 2014 stations) and to the Philippines (AURORA 2007 stations). The sizable Indo-West Pacific collection of the Florida Museum of Natural History, University of Florida, Gainesville (UF) was also useful. Specimens from Museums Victoria, Melbourne (NMV); the Australian Museum, Sydney (AM); Phuket Marine Biological Center, Thailand (PMBC); and Naturhistorisches Museum, Vienna (NHMW) were examined. Peter C. Dworschak kindly shared sketches of material seen by him on loan from the Natural History Museum of Denmark (NHMD; formerly Zoological Museum of Copenhagen, ZMUC) and National Museum of the Philippines, Manila (NMCR).

Material examined of common species has been shortened to list localities, museums, sexes and size ranges – full details are available online from the museums specified. Details (personnel, dates, maps) of MNHN expeditions/campaigns can be found at <https://expeditions.mnhn.fr>. Unless otherwise stated, station prefixes and numbers belong to systems initiated by the museum holding the material.

Size is expressed as carapace length (cl.), including rostrum, in mm. Individuals marked with an asterisk (\*) were sequenced and contributed to the molecular analysis of Robles et al. (2020); those marked with a hash (#) were sequenced by Qi Kou, Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China. The diagnosis of the new genus and updated diagnoses of *Praedatrypaea* and *Pugnatrypaea* were derived from the edited DELTA database (Dallwitz, 2018) used by Poore et al. (2019). New DELTA databases were created to generate diagnoses of species of *Praedatrypaea* and *Aqaballianassa*.

Illustrations were prepared by tracing in Aboide Illustrator® pencil drawings made using a camera lucida. For simplicity, not all setae are shown. Poore et al. (2019) diagnosed two genera, *Cavallianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 and *Rudisullianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019 with a “maxilliped 3 ... dactylus ovate, with dense brush of long setae over most of upper-distal margin, few setae along lower margin”. This is figured here for three species (fig. 1b, h, i)

where the dactylus is contrasted with the usual setal arrangement in other genera in which marginal setae are not so clustered and concentrated on the lower distal margin (fig. 1c–g, j–l).

Colour photographs of fresh specimens were taken in the laboratory shortly after collection by Tin-Yam Chan and Zdeněk Ďuriš. Photographs in fig. 1 were taken using a Olympus 205C microscope and the Zerene Stacker routine.

Distribution are given in terms of Marine Ecoregions of the World (MEOW) realms or provinces (Spalding et al., 2007), with political terms in parentheses.

## Taxonomy

### Family Callianassidae Dana, 1852

#### *Aqaballianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019

*Aqaballianassa* Poore et al., 2019: 90–91.—Robles et al., 2020).—Poore and Ah Yong, 2023: 211.

**Remarks.** *Aqaballianassa* is recognised primarily by the presence of a branchiostegal sclerite isolating the anterodorsal corner of the branchiostegite (Dworschak, 2003; Poore et al., 2019). The mandibular molar seems characteristic of this genus only (fig. 3l, m); it is calcified with a swollen molar process lacking a sharp edge and an incisor with few teeth (Poore et al., 2019). Poore et al. (2019) recognised eight named species (Table 1), some rather poorly described and not easily differentiated. Robles et al.'s (2020) molecular phylogram included three named species and another as *Aqaballianassa* PNG-116. The identity of the last was supported by sequences from four individuals and is described here as *A. papua* sp. nov. Another new species, not part of the molecular study, *A. seychellensis* sp. nov., is also described.

Species of *Aqaballianassa* are differentiated largely on the shapes of the eyestalk, rostrum and anterior carapace margin, telson and uropod, and extent of the cervical groove. Descriptions of some nominal species are incomplete.

*Aqaballianassa* contains both gonochoristic and hermaphroditic species. Both sexes of *A. lewtonae* are known, males and females having different pleopods 1 and 2. All specimens of *A. papua* have female gonopores on the coxae of pereopod 3; all including the ovigerous individual have male gonopores on the coxae of pereopods 5. Dworschak (2003) labelled the largest specimen of *A. aqabaensis* a male but noted the presence of gonopores on pereopods 3 and 5, leading him to call it “intersex”. This specimen has a uniarticulate pleopod 1 and a bud-like pleopod 2. His illustration of the chelipeds are similar to those of ovigerous “females” of *A. lewtonae* (fig. 3n) and *A. papua*. The male chelipeds of *A. lewtonae* (fig. 3g, h) show the dimorphism typical of many callianassids, a short carpus and gaping fingers. Pleopod 1 of *A. lewtonae* is uniarticulate, as in *A. aqabaensis*; pleopod 2 is biramous, whereas it is bud-like in *A. aqabaensis*. All other species are known from one or few individuals identified as female.





Figure 1. Dactylus of maxilliped 3 of representatives of two callianassoid families. Eucalliacidae. a, *Calliixina kensleyi* (Dworschak, 2005), MNHN IU-2016-8084. Callianassidae. b, *Cavallianassa moorea* sp. nov., UF 28875; c, *Paratrypaea* sp., MNHN IU-2013-7035; d, *Praedatrypaea lobetobensis* sp. nov., MNHN IU-2015-109; e, *Praedatrypaea orientalis* (Bate, 1888), AM P.74473; f, *Rayllianassa amboinensis* (De Man, 1888), UF 8700; g, *Rayllianassa bifida* sp. nov., MNHN IU-2013-7137; h, *Rudisullianassa pandan* sp. nov., MNHN IU-2013-7063; i, *Rudisullianassa rudisulcus* Komai, Fujita and Maenosono, 2014, MNHN IU-2013-7121; j, *Scallasis amboinae* Bate, 1888, MNHN IU-2013-12303; k, *Spinicallianassa spinicauda* (Komai, Maenosono and Fujita, 2014), MNHN IU-2014-2778; l, *Spinicallianassa papetoai* sp. nov., UF 29280.

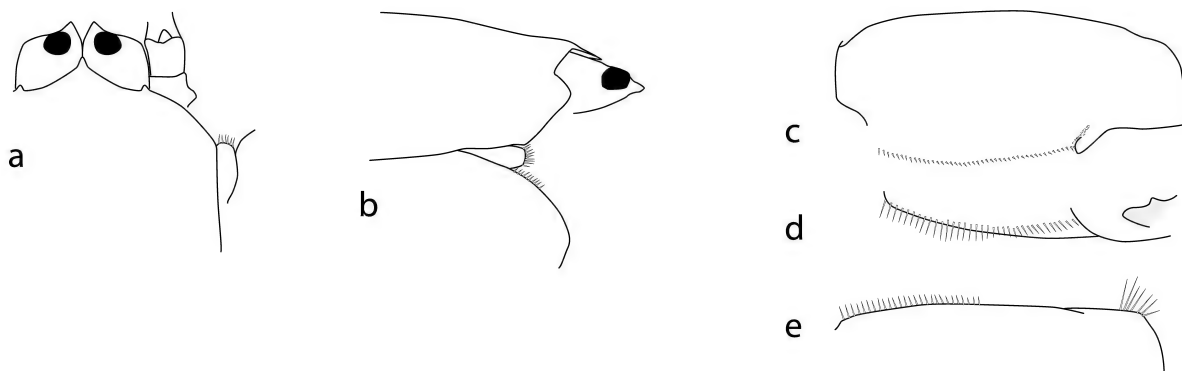


Figure 2. *Aqaballianassa aqabaensis* (Dworschak, 2003). Jordan. NHMW 16764, male, 5.4 mm: a, b, anterior carapace, eyestalks, antennal peduncle (dorsal, lateral views). c–e, pleomere 6 (lateral left; ventral right side, uropod articulation shaded; dorsal right side views).

Table 1. Distribution of species of *Aqaballianassa* in terms of MEOW provinces and political areas.

Species	Distribution
<i>A. amplimaxilla</i> (Sakai, 2002)	Andaman (Thailand)
<i>A. aqabaensis</i> (Dworschak, 2003)	Red Sea and Gulf of Aden, Western Coral Triangle (Jordan, Egypt, Philippines, Indonesia)
<i>A. brevirostris</i> (Sakai, 2002)	Andaman (Thailand, Singapore)
<i>A. ehsani</i> (Sepahvand, Tudge and Momtazi, 2018)	Somali/Arabian (Gulf of Oman)
<i>A. lewtonae</i> (Ngoc-Ho, 1994)	Northeast Australian Shelf, Eastern Coral Triangle (Qld, Australia; Papua New Guinea)
<i>A. nieli</i> (Sakai, 2002)	Andaman (Thailand)
<i>A. papua</i> sp. nov.	Eastern Coral Triangle (Papua New Guinea)
<i>A. seychellensis</i> sp. nov.	Western Indian Ocean (Seychelles)
<i>A. spinoculata</i> (Sakai, 2005)	Sunda Shelf (Malaysia)
<i>A. thorsoni</i> (Sakai, 2005)	Somali/Arabian (Persian Gulf)

### *Aqaballianassa aqabaensis* (Dworschak, 2003)

#### Figure 2

*Callianassa aqabaensis* Dworschak, 2003: 416–426, figs 2–36.—Robles et al., 2009: 316.

*Cheramus aqabaensis*.—Sakai, 2011: 367.

*Aqaballianassa aqabaensis*.—Poore et al., 2019: 91, 136, 142.—Robles et al., 2020: figs 1, 3, 6.—Dworschak, 2022: 251–252.

**Material examined.** **Jordan.** Aqaba, Murjan, 10–14 m, holotype, paratypes, other specimens, NHMW 15759–16777 (5.0–6.2 mm).

**Diagnosis.** Major cheliped merus 1.8 times as long as wide, lower margin with distally directed proximal spine; propodus palm 1.8 times as long as carpus, 1.2 times as long as wide, with oblique gape (narrower than base of each finger), without tooth; fixed finger half as long as palm, with subdistal tooth on cutting edge; dactylus as long as fixed finger. Uropod endopod oval, 1.2 times as long as greatest width, upper face with at least 2 short spiniform setae; exopod wider than length of anterior margin. Telson 1.1 times as long as wide, tapering to about 0.9 greatest width.

**Distribution.** Western and Central Indo-Pacific (Jordan [type locality: Aqaba], Philippines, Indonesia); 10–14 m.

**Remarks.** Dworschak (2003) illustrated the small ‘branchiostegal sclerite’ below the anterior of the linea thalassinica but did not note that the suture separating it from the branchiostegite is incomplete (fig. 2a, b). Pleomere 6 has an oblique groove posteriorly on the ventrolateral margin (fig. 2c–e) as do all species of *Aqaballianassa*.

Sakai (2011) placed the species in *Cheramus* without explanation.

### *Aqaballianassa brevirostris* (Sakai, 2002)

*Callianassa brevirostris* Sakai, 2002: 514–518, figs 30, 31.

*Trypaea brevirostris*.—Sakai, 2011: 394.

*Aqaballianassa brevirostris*.—Poore et al., 2019: 91, 136, 142.—Robles et al., 2020: figs 1, 3, 6.—Dworschak and Anker, 2022: 114: fig. 1c (colour photograph).

**Material examined.** **Thailand.** Andaman Sea, off Phuket, 59 m, 07° 30' N, 98° 29' E (BIOSHSELF stn I2), PMBC 15710 (female, 2.5 mm); 21 m, 07° 52' N, 98° 48' E (BIOSHSELF stn PB5), PMBC 15713 (male, 2.0 mm).

**Diagnosis.** Major cheliped merus 1.7 times as long as wide, lower margin with distally directed proximal spine; propodus palm as long as carpus, as long as wide, with oblique gape (narrower than base of each finger), without tooth; fixed finger 0.65 times as long as palm, without tooth on cutting edge. Dactylus longer than fixed finger. Uropod endopod oval, 1.2 times as long as greatest width; exopod anterior margin 1.5 times greatest width. Telson 1.1 times as long as wide, tapering to convex posterior margin (not as figured by Sakai, 2002).

**Distribution.** Andaman, Sunda Shelf (Thailand, Singapore, [type locality: Andaman Sea]); 0–73 m.

**Remarks.** Sakai (2002) reported males and females. The female and male major chelipeds (Sakai's fig. 31C, D) are, as in hermaphroditic *A. aqabaensis*, not highly sexually dimorphic, if the illustrated “detached” cheliped is in fact from a male. The paratype male was reported to have a 2-articled pleopod 1; the smaller juvenile male reported here lacks pleopods 1 and 2.

Sakai (2011) placed the species in *Trypaea* without explanation. The branchiostegal sclerite is smaller than illustrated by Sakai (2002) but confirms the present generic placement.

### *Aqaballianassa lewtonae* (Ngoc-Ho, 1994)

#### Figures 3, 4

*Callianassa lewtonae* Ngoc-Ho, 1994: 52–54, fig. 1.—Sakai, 1999: 47.—Sakai, 2005: 90.

*Biffarius lewtonae*.—Tudge et al., 2000: 143.—Davie, 2002: 457.

*Trypaea lewtonae*.—Sakai, 2011: 402.

*Aqaballianassa lewtonae*.—Poore et al., 2019: 91, 136, 142.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** **Australia.** Qld, Britomart Reef, 18° 7' S, 146° 38' E, reef front, 15 m, NMV J22659 (holotype ovigerous female, 5.0 mm). Pandora Reef, 18° 49' S, 146° 26' E, reef flat, 1 m, NMV J22684 (paratype female, 4.0 mm). Qld, NE of Townsville, 18° 43' S, 146° 45' E, 34 m, MNHN Th-1247 (paratype, ovigerous female, 5 mm). Lizard

I., Casuarina Beach, UF 17514 (ovigerous female, 4.7 mm), UF 17583 (male, 3.1 mm). NT, Arafura Sea: 9° 47.947' S, 135° 22.024' E, 92 m, calcareous mud (CSIRO stn SS05/2005/002/BS002), AM P.74527 (female, 2.9 mm with *Sacculina* plus male and female Bopyridae; female 3.5 mm); 9° 47.593' S, 135° 16.636' E, 85 m, muddy sand (CSIRO stn SS05/2005/012/GR019), AM P.74476B (3 females, 3.0 mm); 9° 22.547' S, 134° 3.585' E, 121 m, calcareous mud (CSIRO stn SS05/2005/022/GR038), AM P.74498 (female, 1.8 mm); 9° 52.788' S, 135° 21.891' E, 69 m, sandy mud (CSIRO stn SS05/2005/003/GR005), AM P.74499 (5 specimens, 2.1–3.1 mm); 9° 52.788' S,

135° 21.891' E, 69 m, sandy mud (CSIRO stn SS05/2005/003/GR005), AM P.74505 (female, 3.2 mm); 9° 50.035' S, 135° 17.74' E, 83 m, (CSIRO stn SS05/2005/007/BS003), AM P.74513 (1 male, 2 females, 2.8–3.0 mm); 9° 47.986' S, 135° 22.997' E, 91 m, calcareous mud (CSIRO stn SS05/2005/002/GR003), AM P.74514 (3 females, 2.5–3.3 mm); 9° 48.774' S, 135° 15.412' E, 82 m, sandy mud (CSIRO stn SS05/2005/010/GR017), AM P.74523 (female, 2.9 mm); 9° 50.126' S, 135° 17.766' E, 83 m, muddy fine sand (CSIRO stn SS05/2005/007/GR011), AM P.74525 (female, 3.2 mm); 9° 44.316' S, 135° 15.947' E, 102 m, calcareous mud (CSIRO stn SS05/2005/064/GR084), AM

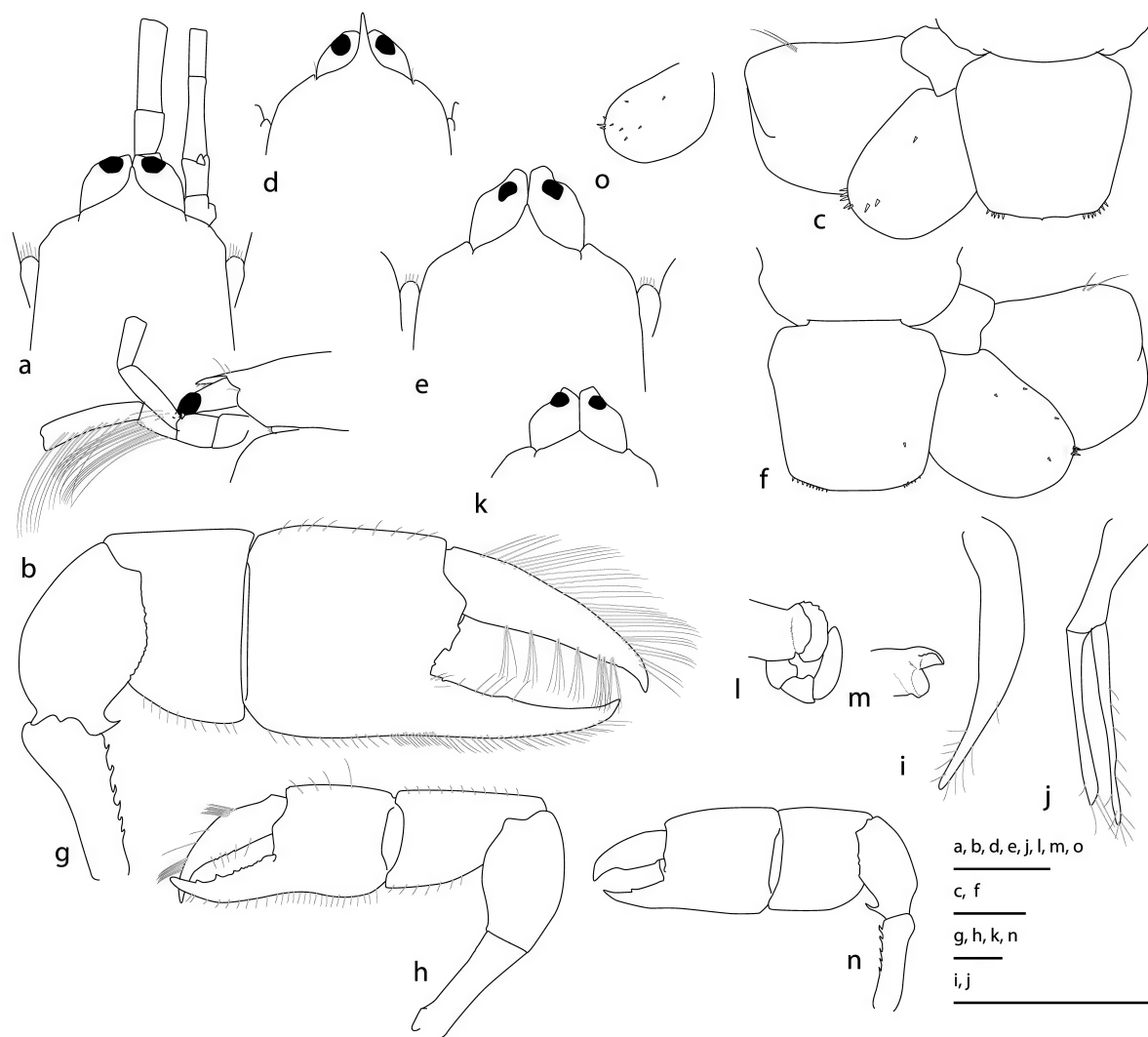


Figure 3. *Aqaballianassa lewtonae* (Ngoc-Ho, 1994). a–c, Australia, Qld, NMV J22659, holotype, ovigerous female, 5.0 mm; d, Australia, Qld, NMV J22684, paratype, female, 4.4 mm. e–i, Papua New Guinea, Madang, MNHN IU-2016-8152, male, 5.9 mm; j–m, Papua New Guinea, Madang, MNHN IU-2016-8155, ovigerous female, 4.2 mm; n, o, Australia, Qld, UF 17583, male, 3.1 mm. a, b, d, e, k, anterior carapace, eyestalk, antennular, antennal peduncles; c, e, f, telson, uropod (short robust setae and facial setae only shown, marginal setae not shown); g, male major cheliped (left, mesial); h, male minor cheliped (right, mesial); i, j, male pleopods 1, 2; l, m, mandible (mesial, posterior views); n, female major cheliped (right, mesial); o, left uropodal endopod. Scale bars = 1 mm.

P.74528 (female, 3.8 mm); 9° 47.94' S, 135° 22.024' E, 92 m, calcareous mud (CSIRO stn SS05/2005/002/BS002), AM P.74539 (female, 3.8 mm); 9° 49.294' S, 135° 19.599' E, 83 m, calcareous mud (CSIRO stn SS05/2005/009/GR015), AM P.74541 (1); 9° 52.788' S, 135° 21.891' E, 69 m, sandy mud (CSIRO stn SS05/2005/003/GR005), AM P.74478 (juvenile, 3.6 mm); 9° 47.986' S, 135° 22.007' E, 91 m, calcareous mud (CSIRO stn SS05/2005/002/GR002), AM P.74449 (1). **Papua New Guinea.** Madang Province, W of Tab I., 05° 10.2' S, 145° 50.4' E, 1–3 m (PAPUA NIUGINI stn PR243), MNHN IU-2013-7080\* (female, 5.6 mm), MNHN IU-2013-7090 (female, 3.4 mm), MNHN IU-2013-7112 (female, 3.9 mm). New Britain, Kavieng Lagoon, Nago I. wharf, sand, 02° 36.3' S, 150° 46.2' E, 3–12 m (KAVIENG 2014 stn KR06), MNHN IU-2013-8835\* (male, 3.7 mm). Kavieng Lagoon, in front of market, silty rocks with algae, 02° 34.7' S, 150° 47.5' E, 1–2 m (KAVIENG 2014 stn KZ16), MNHN IU-2014-2779\* (male, 2.6 mm), MNHN IU-2014-2780 (female, 3.0 mm). New Ireland, E of North Cape, dead reef on top, sand and coral bommies, 02° 33.2' S, 150° 48.4' E, 5–20 m (KAVIENG 2014 stn KZ10), MNHN IU-2014-10001 (6 specimens, 1 with isopod Bopyridae), MNHN IU-2016-8152\*# (male, 5.9 mm), MNHN IU-2016-8153\*# (ovigerous female, 3.9 mm), MNHN IU-2016-8155\* (ovigerous female, 4.2 mm).

**Diagnosis.** Major cheliped merus 1.5 times as long as wide, lower margin with distally directed proximal tooth; propodus palm 1.3 times as long as carpus, as long as wide, with oblique gape (wider than base of each finger) bearing short flange-like tooth; fixed finger as long as palm; dactylus longer than fixed finger. Uropod endopod oval, 1.3 times as long as greatest width; upper face with 1 or 2 subproximal and 2 subdistal short spiniform setae; anterior margin curved distally; curved anterodistal margin with 3–6 short spiniform setae; exopod wider or as wide as length of anterior margin. Telson as long as wide, tapering to about 0.7 greatest width; posterolateral margins with 5–10 short spiniform setae.

**Supplementary description.** Branchiostegal sclerite incompletely separated from branchiostegite proper. Rostrum variable, blunt in smallest individuals, one third as long as eyestalk, to tapered, more than half or almost as long as eyestalk in largest individuals. Eyestalk with obscure or prominent distomedial lobe beyond cornea. Antennal peduncle as long as antennular peduncle;

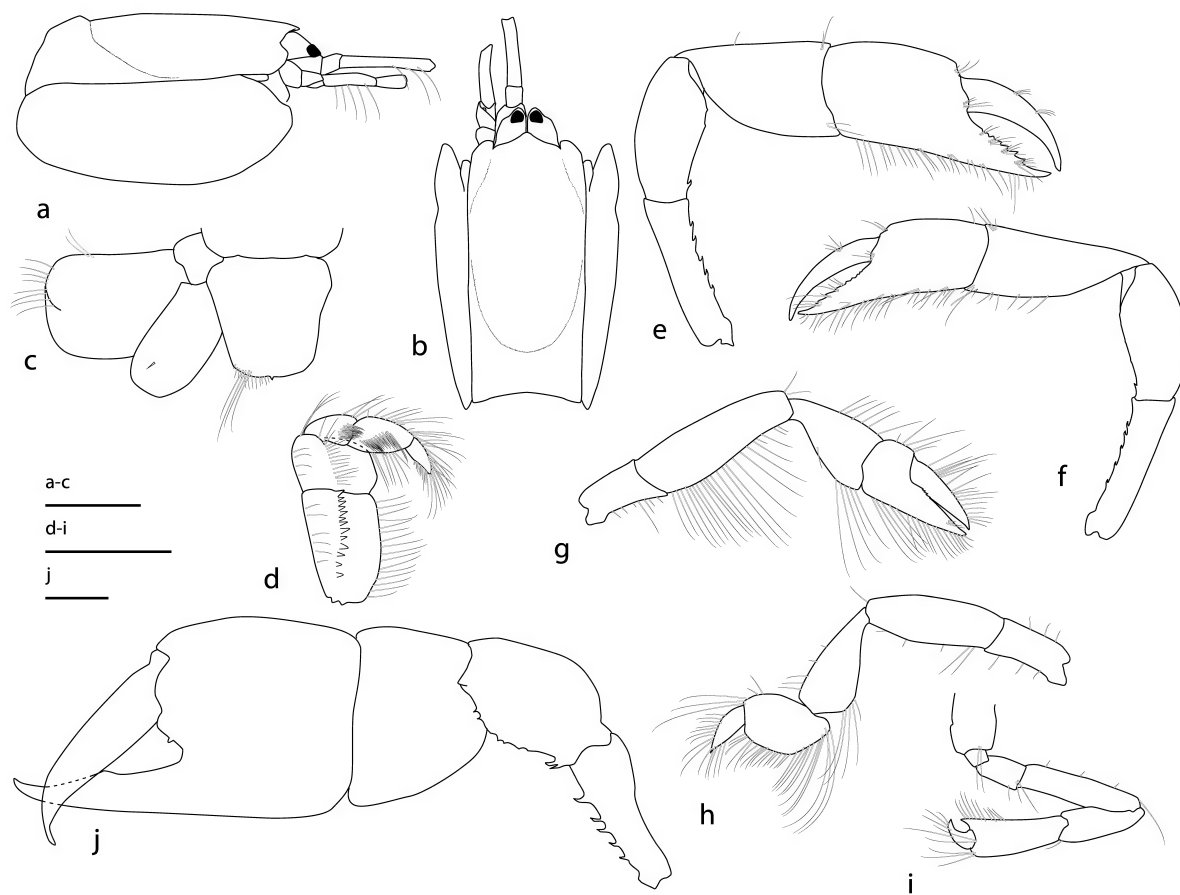


Figure 4. *Aqaballianassa lewtonae* (Ngoc-Ho, 1994). Australia, NT, Arafura Sea. AM P.74541, ovigerous female, 2.7 mm: a, b, carapace, antennular, antennal peduncles (lateral, dorsal views); c, telson, uropod (marginal setae not shown); d, maxilliped 3; e, major (left, mesial) cheliped; f, minor (right, mesial) cheliped; g–i, pereopods 2, 3, 5. AM P.745539, ovigerous female, 3.7 mm: j, major cheliped (right, mesial). Scale bars = 1 mm.

scaphocerite slightly longer than wide, with rounded apex. Mandibular molar calcified, chalky-white, with swollen projection lacking sharp edge; incisor with few teeth. Male minor cheliped three-quarters length of major cheliped; ischium, merus lower margins unarmed; propodus palm 0.7 times as long as carpus, as long as wide, with gape (narrower than base of each finger), fixed finger as long as palm, with irregular teeth on cutting edge; dactylus as long as fixed finger. Female major cheliped ischium lower margin with 5 teeth; merus twice as long as wide, lower margin with distally directed spine; propodus palm 1.25 times as long as carpus, 1.1 times as long as wide, with oblique gape (narrower than base of each finger) bearing mesial tubercle, fixed finger half as long as palm; dactylus stout, overreaching fixed finger.

Male pleopod 1 uniarticulate, curved, tapering over distal third, with few subdistal setae. Male pleopod 2 rami elongate, uniarticulate; exopod 12 times as long as width at base, longer than endopod.

**Distribution.** Sahul Shelf, Eastern Coral Triangle, Northeastern Australian Shelf (Australia, NT, Qld, northern Great Barrier Reef [type locality: Britomart Reef]; Papua New Guinea); 1–20 m.

**Remarks.** Ngoc-Ho's (1994) figures only vaguely indicated the branchiostegal sclerite that characterises the genus; the three type specimens listed are all females. Here, the male and female chelipeds, setation of the uropod and telson, and male pleopods are illustrated for the first time. The holotype is an ovigerous female (5.0 mm) whose major cheliped is more elongate and lacks a meral tooth. *Aqaballianassa lewtonae* is distinguished from other species of the genus by the telson, as long as wide and clearly tapering. The length of the rostrum varies in length from obtusely triangular to well exceeding the eyestalks. While the uropodal exopod is consistently squarish, as is the case for most species, the endopod varies in width.

*Aqaballianassa amplimaxilla* (Sakai, 2002) and *A. nieli* (Sakai, 2002), both based on numerous damaged individuals from the Andaman Sea and incompletely described, are possible synonyms of *A. lewtonae*.

Sakai (2011) placed the species in *Trypaea* without explanation. *Aqaballianassa lewtonae* and *A. papua* sp. nov. occurred at the same station (KR06) in the Kavieng Lagoon.

### *Aqaballianassa papua* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:0BA416C6-E2F4-444C-A629-B714EC4D617A>

Figures 1a, 5–7

*Aqaballianassa* PNG-1166.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** Holotype. **Papua New Guinea.** Madang Province, W of Tab I., 05° 10.2' S, 145° 50.4' E, 1–3 m (PAPUA NIUGINI stn PR243), MNHN IU-2013-7117\* (hermaphrodite, 4.1 mm). Paratypes. **Papua New Guinea.** Madang Province, NE of Tab I., 1–22 m (PAPUA NIUGINI stn PR155), MNHN IU-2013-7114\*# (hermaphrodite, 3.4 mm), MNHN IU-2016-8150 (ovigerous hermaphrodite, 3.2 mm); W of Tab I., 05° 10.2' S, 145° 50.4' E, 1–3 m (PAPUA NIUGINI stn PR243), MNHN IU-2013-7107 (ovigerous female, 3.1 mm). New Britain, Kavieng Lagoon, Nago I. wharf, sand, 02° 36.3' S, 150° 46.2' E, 3–12 m (KAVIENG 2014 stn KR06), MNHN IU-2016-8151\*#

(hermaphrodite, 3.6 mm), MNHN IU-2014-1056 (hermaphrodite, 4.1 mm); N of Sek I., inner slope, 05° 04.7' S, 145° 48.9' E, 8 m (PAPUA NIUGINI stn PS47), MNHN IU-2013-7068\* (juvenile, 2.3 mm); MNHN IU-2017-1356 (juvenile, 2.5 mm).

**Diagnosis.** Major cheliped merus 1.6 times as long as wide, lower margin with distally directed proximal tooth; propodus palm 1.25 times as long as carpus, as long as wide, with oblique gape (as wide as base of each finger) bearing distolateral short square tooth; fixed finger 0.6 length of palm; dactylus stout, overreaching fixed finger. Uropod endopod oval-tapering, widest proximally, 1.1 times as long as greatest width; upper face usually with 1 subproximal and 2 subdistal short spiniform setae; anterior margin convex, or straight with subdistal spine; anterodistal margin with 1–3 short spiniform setae; exopod 1.2–1.3 times as wide as length of anterior margin. Telson 1.23 times as wide as long, tapering to about three-quarters greatest width; posterolateral margins with 1 or 2 short spiniform setae, posterior margin sometimes with spiniform seta(e) near midpoint.

**Description of holotype.** Hermaphrodite. Rostrum triangular, acute, with sharp lateral margin and slight ventral keel, situated level with dorsal carapace, shorter than eyestalks. Carapace dorsally flat, as long as pleomeres 1 and 2 combined; orbital margin almost transverse, separated from anterolateral angle by deep notch; anterolateral angle directed anteriorly; subanterolateral margin oblique; branchiostegal sclerite elongate-oval, protected laterally by domed section dorsal margin of branchiostegite; anterior margin of branchiostegite convex; cervical groove deeply incised, across 0.8 length of carapace, reaching linea thalassinica. Thoracic sternite 7 wider than long, anterior margin with broad rounded median lobe; ventral surface flat. Pleomere 1 tergite with transverse groove, posterior half much wider than anterior half. Pleomere 2 1.1 times as long as wide. Pleomeres 3–5 each wider than long; pleura each with patch of plumose setae. Pleomere 6 about as long as wide, 1.1 times as long as pleomere 5, with posterior lateral groove dorsal to ridge leading to lateral notch.

Eyestalk about 1.3 times as long as wide, with dorsal face close to rostrum; sharp ventrolateral margin, anterolateral margin oblique, anteromedial angle rounded or angular in dorsal view, overreaching distal margin of antennular peduncle article 1. Cornea densely pigmented, occupying anterolateral margin of eyestalk.

Antennular peduncle reaching beyond distal margin of antennal peduncle; article 1 not visible in dorsal view; article 3 little longer than articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 half as long as article 4; scaphocerite minute, comma-shaped, with acute apex.

Mandible molar process rounded, without tooth; incisor process with proximal obsolete teeth. Maxilliped 3 ischium dilating distally, 1.2 times as long as wide, crista dentata consisting of row of about 11 small, well-spaced teeth, stronger distally; merus about half as long as ischium measured along outer margin, about twice as wide as long, wider than ischium, with mesiodistal margin produced as convex lobe beyond base of carpus; carpus longer than merus outer margin; propodus ovoid-tapering, 1.7 times as long as wide; dactylus digitiform, 0.6 times as long as propodus.

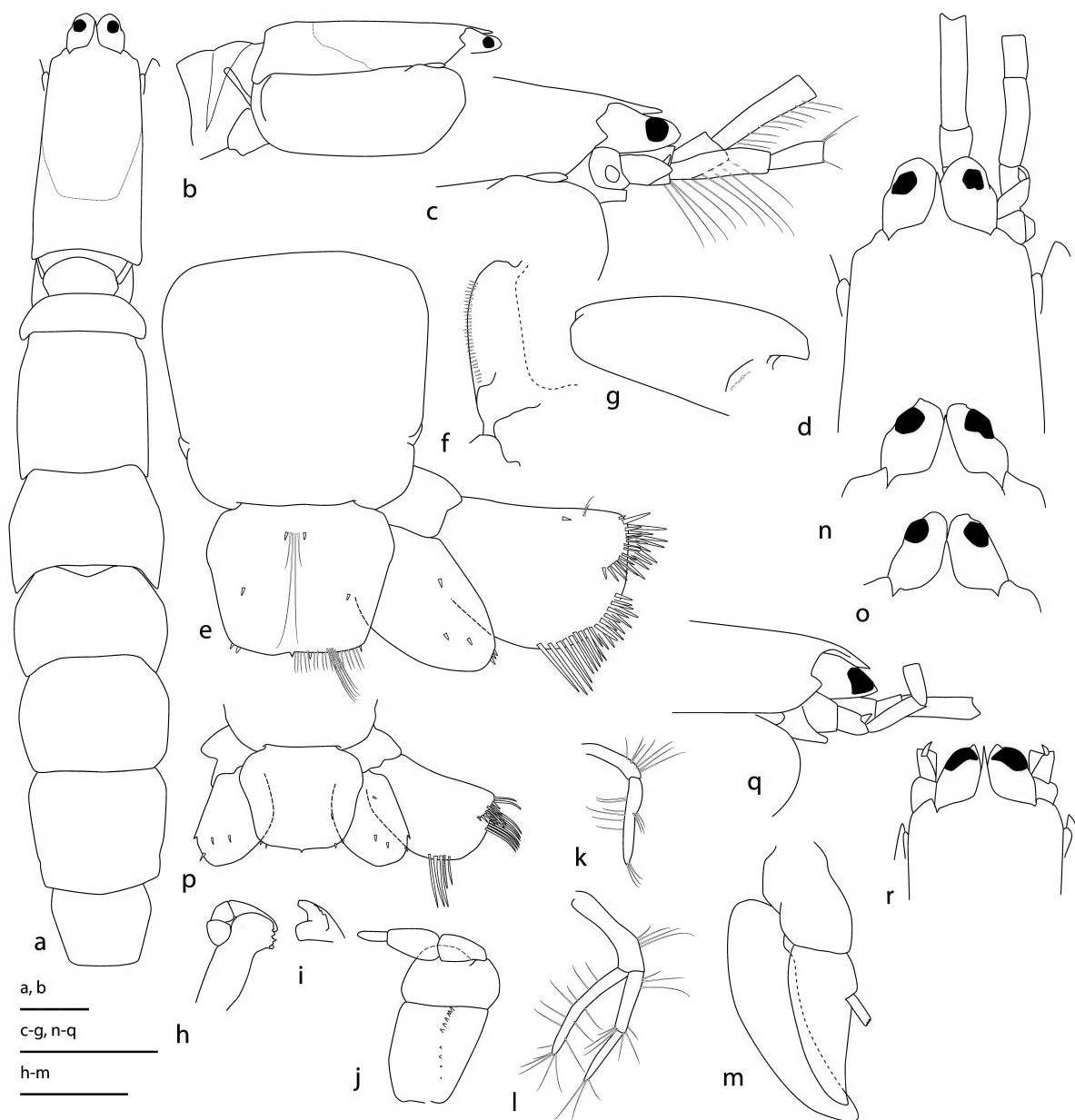


Figure 5. *Aqaballianassa papua* sp. nov. Papua New Guinea. MNHN IU-2013-7117, holotype hermaphrodite, 4.1 mm: a, dorsal carapace, pleon, telson; b, lateral carapace, pleomere 1; c, d, anterior carapace, eyestalk, antennule, antennal peduncles; e, pleomere 6, uropod, telson; f, g, pleomere 6 ventral, left lateral; h, left mandible, lateral; i, right mandible, mesial; j, maxilliped; k–m, pleopods 1–3. MNHN IU-2016-8150, ovigerous female, 3.2 mm: n, anterior carapace, eyestalks. MNHN IU-2016-8151, female, 3.6 mm: o, anterior carapace, eyestalks. MNHN IU-2013-7068, female, 2.3 mm: p, telson, uropods; q, r, anterior carapace, eyestalks, antennule, antennal peduncles. Scale bars = 1 mm.

Pereopods 1 (chelipeds) unequal, dissimilar. Female major cheliped massive, carpus-palm upper margin 1.2 times carapace length. Ischium barely expanding distally, upper margin concave, unarmed; lower margin with row of 8 spines. Merus as long as ischium, 1.7 times as long as wide (tooth excluded), ovate; upper margin convex, unarmed; lower margin with subproximal spine, scalloped over distal oblique third. Carpus about as long as wide; margins carinate; upper margin smooth; lower margin convex. Propodus upper margin 1.25 times as long as carpus; palm widest subproximally,

tapering, 1.05 times as long as wide; upper margin carinate; lateral surface smooth, convex, with deep concave gape; mesial surface slightly convex, with square tooth set back from distolateral margin; lower margin sharply carinate, with row of setae extending onto fixed finger; fixed finger 0.6 times as long as palm, not depressed; cutting edge with blade along lateral margin; dactylus overreaching fixed finger, hooked distally, with acute tip; upper margin with tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge with small teeth over distal half.

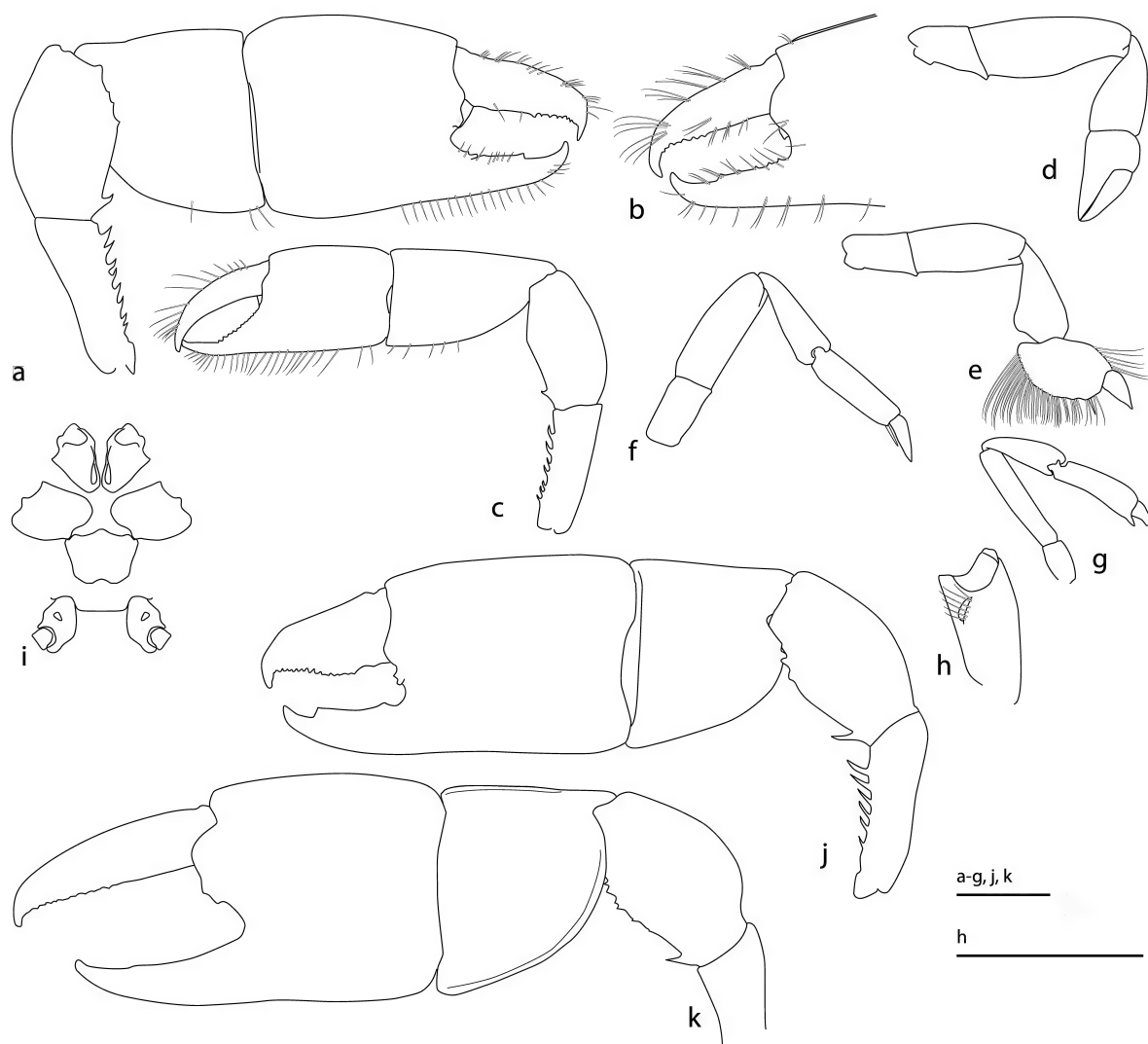


Figure 6. *Aqaballianassa papua* sp. nov. Papua New Guinea. MNHN IU-2013-7117, holotype hermaphrodite, 4.1 mm: a, major cheliped (left, mesial) b, major cheliped fingers (lateral); c, minor cheliped, right; d–g, pereopods 2–5; h, pereopod 5 coxa (mesial); i, thoracic sternum 7, pereopodal coxae 3–5. MNHN IU-2016-8151, hermaphrodite, 3.6 mm: j, major cheliped (right, mesial). MNHN IU-2013-7114, hermaphrodite, 3.4 mm: k, major cheliped (right, mesial). Scale bars = 1 mm.



Figure 7. *Aqaballianassa papua* sp. nov. Papua New Guinea. MNHN IU-2014-1056 (colour photographs by Zdeněk Ďuriš).

Minor cheliped carpus-palm upper margin 0.9 times carapace length. Ischium upper margin smooth, lower margin with row of 7 spines. Merus about as long as ischium; lower margin with tooth about one sixth along. Carpus wider distally, 1.2 times as long as merus, 1.7 times as long as wide. Palm slightly swollen, 1.2 times as long as wide; upper margin barely convex; lower margin sharply carinate, with row of long setae extending onto fixed finger. Fixed finger deep, triangular, three-quarters as long as palm, cutting edge denticulate except over distal third. Dactylus as long as palm, curved; cutting edge smooth.

Pereopod 2 merus lower margin slightly sinusoidal, 2.8 times as long as wide; carpus about 1.8 times as long as wide; chela subtriangular; palm about 1.5 times as wide as upper margin; dactylus twice as long as palm upper margin. Pereopod 3 carpus subtriangular, twice as long as wide; propodus suboval with produced lower proximal margin, upper margin equal to greatest width, lower margin convex, faintly undulate, marginal setae clustered on prominences, with one slender spiniform seta subdistally; dactylus about 0.75 times as long as propodus upper margin. Pereopod 4 coxa flattened ventrally, immovable; merus 1.8 times as long as ischium; carpus 0.8 length of merus; propodus as long as carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with long spiniform setae parallel to dactylus; dactylus half as long as propodus. Pereopod 5 slender; coxa with semicircular gonopore; with chela about as long as carpus, slightly curving, fixed finger shorter than dactylus.

Pleopod 1 of 2 articles at right angles; ramus 1.3 times as long as peduncle; setose. Pleopod 2 biramous; peduncle almost straight; exopod slightly shorter than endopod; endopod of 2 articles. Pleopods 3–5 biramous, rami narrow; appendix interna slender, rod-like, projecting well beyond mesial margin of endopod, bearing short coupling hooks on apical margin.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval-tapering, widest proximally, about 1.3 times as long as wide; upper surface with 1 proximal and 2 distal spiniform setae; anterior margin slightly convex; anterodistal margin with 3–5 short spiniform setae; distal margin narrow-convex, with fringe of setae; posterior margin setose. Exopod widest at midpoint, 1.2 times as long as wide, exceeding endopod by about half its length; anterior margin slightly concave, with 1 spiniform seta and 2 submarginal slender setae about two-thirds along; all margins with numerous slender setae, with more than 20 blade-like setae indistinguishably merged with distal margin; dorsal plate extending about one third across exopod, with row of about 15 stiff setae merging anteriorly with similar setae on distal margin.

Telson trapezoidal, 1.25 times as wide as long, broadest at anterior third, narrowing posteriorly; greatest width 1.4 times posterior width; dorsal surface with few medial setae and pair of spiniform setae near anterior margin, second pair of lateral spiniform setae posterior to midlength; posterolateral angle with 1 or 2 spiniform setae; posterior margin with median tooth.

**Variation.** Rostrum wider, longer and more depressed in some individuals than others; eyestalk mesiodistal lobe angular to rounded (cf. fig. 5c, d, n, o, q, r). Uropod endopod narrower and more tapered in larger individuals than juveniles (cf. fig. 5e, p), with small tooth on anterior margin in one juvenile (fig. 5p).

**Colour.** Carapace and pleon essentially translucent/white with pale orange dorsal band across anterior of carapace. Chelipeds carpi with asymmetrical distal pale orange band; palms with patchy orange colour distolaterally (fig. 7).

**Etymology.** From Papua New Guinea (noun in apposition).

**Distribution.** Eastern and Western Coral Triangle (Papua New Guinea, Indonesia); 1–22 m.

**Remarks.** Robles et al.'s (2020) molecular phylogram attributed four individuals (of seven) to *Aqaballianassa* PNG-116, one remote from the other three. Only hermaphrodites are known, all individuals with both female and male gonopores on pereopodal coxae 3 and 5 respectively. *Aqaballianassa papua* has a shorter telson and usually a longer rostrum than the other common species from the region, *A. lewtonae*. The major cheliped of two of the largest individuals has a shallow gape between the cheliped fingers with a molar-like tooth on the mesial margin (fig. 6a, i); another of similar size has a deeper gape and a blunt mesial tooth.



*Aqaballianassa seychellensis* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:7EC933D6-FF09-46EB-AEC6-E00BF62AE4E2>

Figure 8

**Material examined.** Holotype. **Seychelles**, W of Farquhar Group, 10° 08' S, 50° 59' E, 73–90 m, RV Mahine cruise 336, stn 56(D-12), coral rubble, MNHN IU-2016-8095 (female, 4.9 mm, without maxillipeds). Paratype. Collected with holotype, MNHN IU-2016-8096 (ovigerous female, 2.8 mm, carapace detached, without maxillipeds, major cheliped or pereopods 2–4).

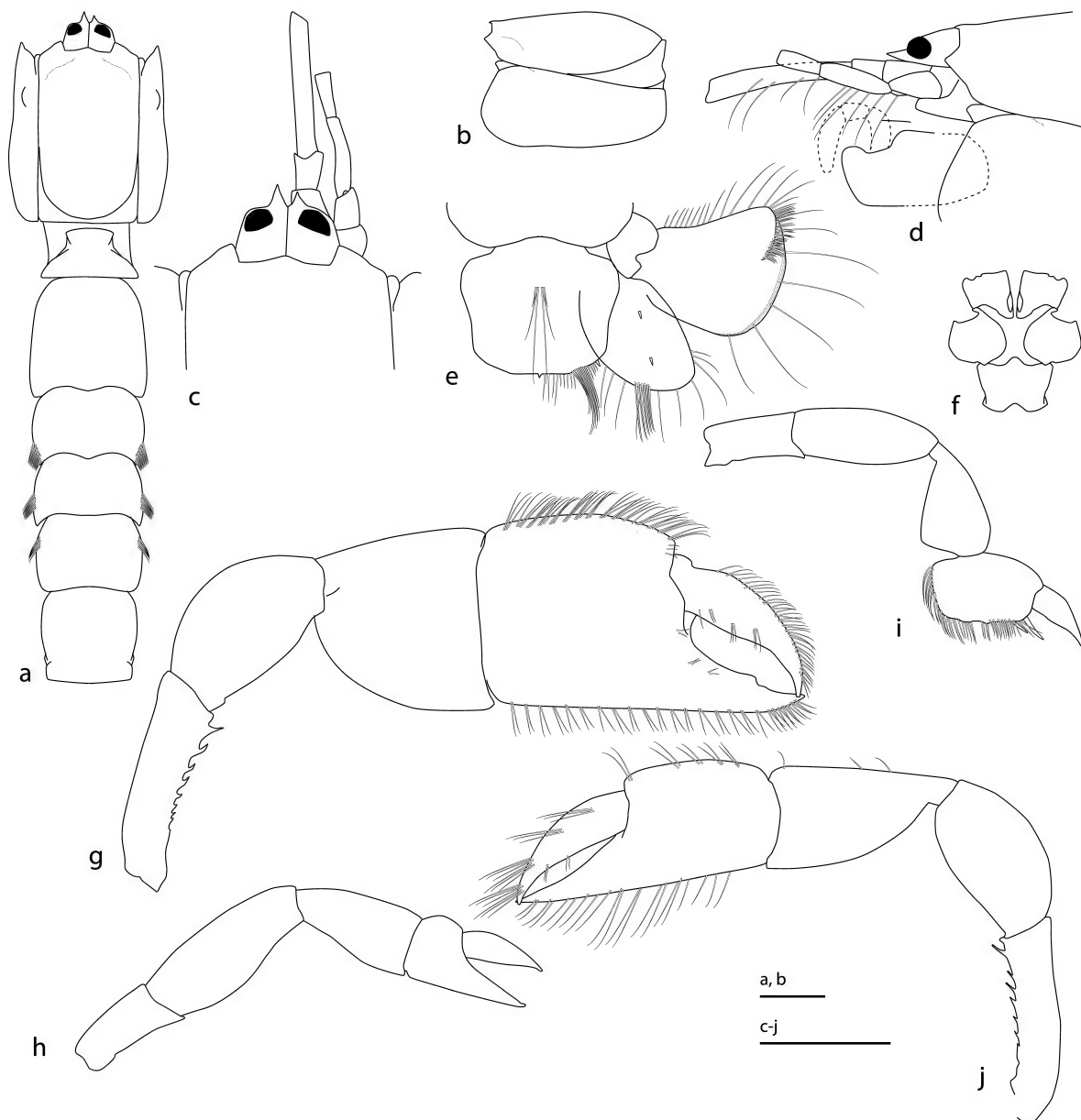


Figure 8. *Aqaballianassa seychellensis* sp. nov. Seychelles. MNHN IU-2016-8095, holotype female, 4.9 mm: a, carapace, pleon; b, carapace; c, anterior carapace, eyestalks, antennulars, antennal peduncles; d, anterior carapace, eyestalks, antennulars, antennal peduncles, mandible; e, telson, uropod (representative marginal setae only); f, thoracic sternite 7, pereopodal coxae 3, 4; g, major cheliped (left, mesial); h, i, pereopods 2, 3. MNHN IU-2016-8096, paratype ovigerous female, 2.8 mm: j, minor cheliped (right, mesial). Scale bars = 1 mm.

**Diagnosis.** Major cheliped merus 1.7 times as long as wide, lower margin with obsolete basal tooth; propodus palm 1.1 times as long as carpus, as long as wide, without wide gape; fixed finger 0.6 length of palm; dactylus as long as fixed finger. Uropod endopod oval-tapering, widest proximally, 1.4 times as long as greatest width; upper surface with 2 spiniform setae in middle row; anterior margin slightly convex; exopod as wide as length of anterior margin. Telson 1.3 times as wide as long, narrowing posteriorly; posterolateral margins with 1 spiniform seta, posterior margin with median tooth.

**Description. Female.** Rostrum obsolete. Carapace dorsally convex, highest at posterior third, as long as pleomeres 1–2 combined; orbital margin almost transverse, set well back from anterolateral angle such that eyestalks appear inset; anterolateral angle directed anteriorly; subanterolateral margin oblique; branchiostegal sclerite elongate-oval, not completely isolated, protected laterally by slightly domed section dorsal margin of branchiostegite; anterior margin of branchiostegite convex; cervical groove deeply incised, reaching linea thalassinica anteriorly, traversing close to posterior margin of carapace, postcervical length about 3% of total carapace length. Thoracic sternite 7 wider than long, anterior margin with prominent rounded median lobe; ventral surface flat. Pleomere 1 tergite with transverse groove, posterior half much wider than anterior half. Pleomere 2 as long as wide. Pleomeres 3–5 each wider than long; pleura each with patch of plumose setae. Pleomere 6 about as long as wide, 1.2 times as long as pleomere 5, with posterior lateral groove dorsal to ridge leading to lateral notch.

Eyestalk about 1.3 times as long as wide, with dorsal face level with rostrum, with sharp ventrolateral margin, anterolateral margin convex, anteromedial angle sharp in dorsal and lateral views, reaching distal margin of antennular peduncle article 1. Cornea pigmented, spherical.

Antennular peduncle exceeding distal margin of antennal peduncle by half of length of article 3; article 1 visible in dorsal view; article 3 about 1.5 times as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 0.7 times as long as article 4; scaphocerite minute, semicircular.

Mandible massive, calcareous. Maxilliped 3 unknown.

Female major cheliped carpus-palm upper margin as long as carapace length. Ischium barely expanding distally, upper margin almost straight, unarmed; lower margin with row of 8 sharp oblique spines. Merus shorter than ischium, 1.7 times as long as wide, ovate; upper margin strongly convex, unarmed; lower margin with obsolete basal tooth. Carpus about as long as wide; margins carinate; upper margin smooth; lower margin convex. Propodus upper margin 1.1 times as long as carpus; palm widest at midpoint, as long as wide; upper margin carinate; lateral surface smooth, convex; mesial surface slightly convex near margins, distolateral margin unarmed; lower margin sharply carinate, with row of setae extending onto fixed finger; fixed finger 0.6 times as long as palm, not depressed; cutting edge with blade along lateral margin ending in blunt step. Dactylus as long as fixed finger, evenly curved, with acute tip; upper margin with tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge without teeth.

Minor cheliped (of paratype) carpus-palm upper margin 0.9 times carapace length. Ischium upper margin smooth, lower margin with row of 7 spines. Merus about 0.8 length of ischium; upper margin convex; lower margin unarmed. Carpus wider distally, 1.2 times as long as merus, 1.8 times as long as wide. Palm slightly swollen, 1.2 times as long as wide; upper margin barely convex; lower margin sharply carinate, with row of long setae extending onto fixed finger. Fixed finger deep, triangular, as long as palm, cutting edge smooth. Dactylus as long as palm, curved; cutting edge smooth.

Pereopod 2 merus lower margin slightly sinusoidal, 2.6 times as long as wide; carpus twice as long as wide; chela subtriangular; palm about 1.7 times as wide as upper margin; dactylus twice as long as palm upper margin. Pereopod 3 carpus subtriangular, 1.7 times as long as wide; propodus subrectangular, with rounded lower proximal margin, upper margin equal to greatest width, lower margin straight, faintly undulate, marginal setae clustered on prominences, with 2 slender spiniform setae subdistally; dactylus about as long as propodus upper margin. Pereopod 4 unknown.

Female pleopods 1–3 typical of genus.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval-tapering, widest proximally, about 1.4 times as long as wide; upper surface with 2 spiniform setae in middle row; anterior margin slightly convex; distoposterior margin convex, with fringe of marginal setae; posterior margin with cluster of about 10 long submarginal setae. Exopod widest at midpoint, as long as wide, scarcely exceeding endopod; anterior margin slightly concave, with row of 8 evenly spaced marginal setae; posterior margin densely setose; upper surface without setae; dorsal plate extending about 0.4 width of exopod, with row of about 40 stiff setae merging anteriorly with setae on distal margin.

Telson trapezoidal, 1.3 times as wide as long, broadest over anterior third, narrowing posteriorly; greatest width 1.3 times posterior width; dorsal surface with 6 long medial setae near anterior margin; posterolateral angle with 1 spiniform seta; posterior margin with median tooth, setose, with submarginal cluster of sublateral setae.

**Etymology.** From the Seychelles, referring to the type locality.

**Distribution.** Western Indian Ocean (Seychelles); 73–90 m (known only from type locality).

**Remarks.** *Aqaballianassa seychellensis* is represented by only two incomplete specimens, which possess the branchiostegal sclerite that characterises this genus as well as general features of the pereopods and tailfan. The new species is instantly recognisable by extremely short postcervical region of the carapace, about 3% of the total carapace length instead of the 25% seen in all other species. The sharp anterior lobes on the eyestalks are unusual – something similar is seen in *A. spinoculata* (Sakai, 2005) and *A. thorsoni* (Sakai, 2005), but neither has the short postcervical region. Neither of these species, nor most others (except *A. aqabaensis* and *A. amplimaxilla* [Sakai, 2002]), possess the deeply set eyestalks between prominent anterolateral lobes seen in *A. seychellensis*. Neither of the two type specimens, one an ovigerous female, possesses a gonopore on the coxa of pereopod 5.

***Caviallianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019**

*Caviallianassa* Poore et al., 2019: 92.—Robles et al., 2020.—Poore and Ahyong, 2023: 211.

**Remarks.** Robles et al. (2020) used tissue from three code-named “species” in their molecular phylogram. They are described as two species here, linked to *Caviallianassa cavifrons* (Komai and Fujiwara, 2012). All share a short flat rostrum, operculiform maxillipeds 3 with dense setae on upper (extensor) margin of the dactylus, compact chelipeds with a row of tubercles on the lower margin of the merus beyond a proximal tooth or series of small short spines. Only the female of the type species, *C. cavifrons*, is known. Here, the male pleopods 1 and 2, maxilliped 3 and the uropodal setation that characterise the genus are figured for one of the new species. The major cheliped, propodus of pereopod 3 and the shape of the uropodal rami differ significantly between species.

*Callianassa thailandica* Sakai, 2005 was listed in *Caviallianassa* by Poore et al. (2019). The species had earlier been included with many others in *Trypaea* (Sakai, 2011). Inclusion in *Caviallianassa* can no longer be justified because the holotype male has a narrow maxilliped 3 quite different from that of other species of *Caviallianassa*. Sakai (2005) illustrated two detached male chelipeds that may belong to different genera – he reported another callianassid, *C. amboinae* (Bate, 1888), now *Scallasis amboinae*, from this locality in the Andaman Sea, *Galathea* stn 394, but the chelipeds are unlikely to be from this species. For the time being, *C. thailandica* is treated as species inquirenda.

**Key to species of *Caviallianassa***

1. Maxilliped 3 merus about 1.3–1.5 times as wide as long ..... 2
- Maxilliped 3 merus about twice as wide as long ..... 3
2. Maxilliped 3 merus with prominent mesiodistal lobe. Telson tapering, with lateral and posterior margins continuous; posterior margin convex ..... *C. aurora*
- Maxilliped 3 merus with broad mesiodistal lobe. Telson tapering to truncate posterior margin ..... *C. cavifrons*
3. Telson posterior margin concave ..... *C. riwo*
- Telson posterior margin straight ..... *C. moorea*

***Caviallianassa arafura* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:B44AFDD2-7D95-4EE0-B91B-5739E250084C>

**Figure 9**

**Material examined.** Holotype. **Australia**, Northern Territory, Arafura Sea, 9° 20.94' S, 134° 3.43' E, 140 m, calcareous gravel (CSIRO stn SS05/2005/023/GR042), AM P.74542 (ovigerous female, 3.5 mm).

**Description.** *Female.* Rostrum triangular, acute, flat, situated level with dorsal carapace, half as long as eyestalks. Carapace

dorsally flat, 0.85 times length of pleomeres 1, 2 combined; orbital margin oblique-transverse; anterolateral angle obtuse; subanterolateral margin concave; anterior margin of branchiostegite with dorsal concavity; cervical groove deeply incised, across 0.75 length of carapace, almost reaching linea thalassinica. Pleomere 1 tergite with transverse groove, posterior half wider than anterior half. Pleomere 2 1.1 times as long as wide. Pleomeres 3–5 each wider than long; pleura each with patch of plumose setae. Pleomere 6 about as long as wide, 1.1 times as long as pleomere 5, with obscure posterolateral groove.

Eyestalk about 2.5 times as long as wide, not concealed by rostrum, basally convex, with lateral margin convex in dorsal view, anteromedial angle well separated, angular in dorsal view, reaching beyond distal margin of antennular peduncle article 1. Cornea densely pigmented, occupying anterolateral margin of eyestalk.

Antennular peduncle reaching beyond distal margin of antennal peduncle; article 1 scarcely visible in dorsal view; article 3 about as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 0.5 times as long as article 4, reaching 0.6 length of antennal article 3; scaphocerite minute, oval.

Maxilliped 3 ischium dilating distally, 1.4 times as wide as long, crista dentata consisting of row of about 12 small sharp teeth; merus shorter than ischium, about as wide as long, with mesiodistal margin well produced as convex lobe beyond base of carpus; carpus about as long as merus outer margin; propodus subrectangular, 1.4 times as long as wide; dactylus 0.8 times as long as propodus, with convex extensor (outer) margin, densely setose distally, with straight flexor (inner) margin bearing several setae.

Female major cheliped massive, carpus-palm upper margin 0.9 carapace length. Ischium upper margin straight, unarmed; lower margin with 5 obsolete teeth. Merus as long as ischium, twice as long as wide, subrectangular; upper margin convex, unarmed; lower margin with 1 small subproximal tooth, with obsolete blade over third quarter. Carpus about as long as wide; margins carinate; upper margin smooth; lower margin convex. Propodus upper margin 1.1 times as long as carpus; palm 1.1 times as long as wide; upper margin carinate, depressed distally; lateral surface smooth, convex; mesial surface slightly convex, with 1 denticle at base of finger; lower margin carinate, with row of clusters of setae extending onto fixed finger; fixed finger 0.6 times as long as palm, not depressed, base 0.65 times length; cutting edge with finely denticulate blade along proximal lateral margin. Dactylus as long as fixed finger, with acute tip; upper margin with tufts of long setae; cutting edge finely denticulate over distal three quarters.

Minor cheliped missing.

Pereopod 2 merus lower margin slightly sinusoidal, 2.5 times as long as wide; carpus about 1.4 times as long as wide; chela subtriangular; palm about twice as wide as upper margin; dactylus 2.3 times as long as palm upper margin. Pereopod 3 carpus subtriangular, 1.7 times as long as wide; propodus oval with broadly produced lower proximal margin, greatest width greater than upper margin, lower margin convex, with subdistal spiniform seta; dactylus about as long

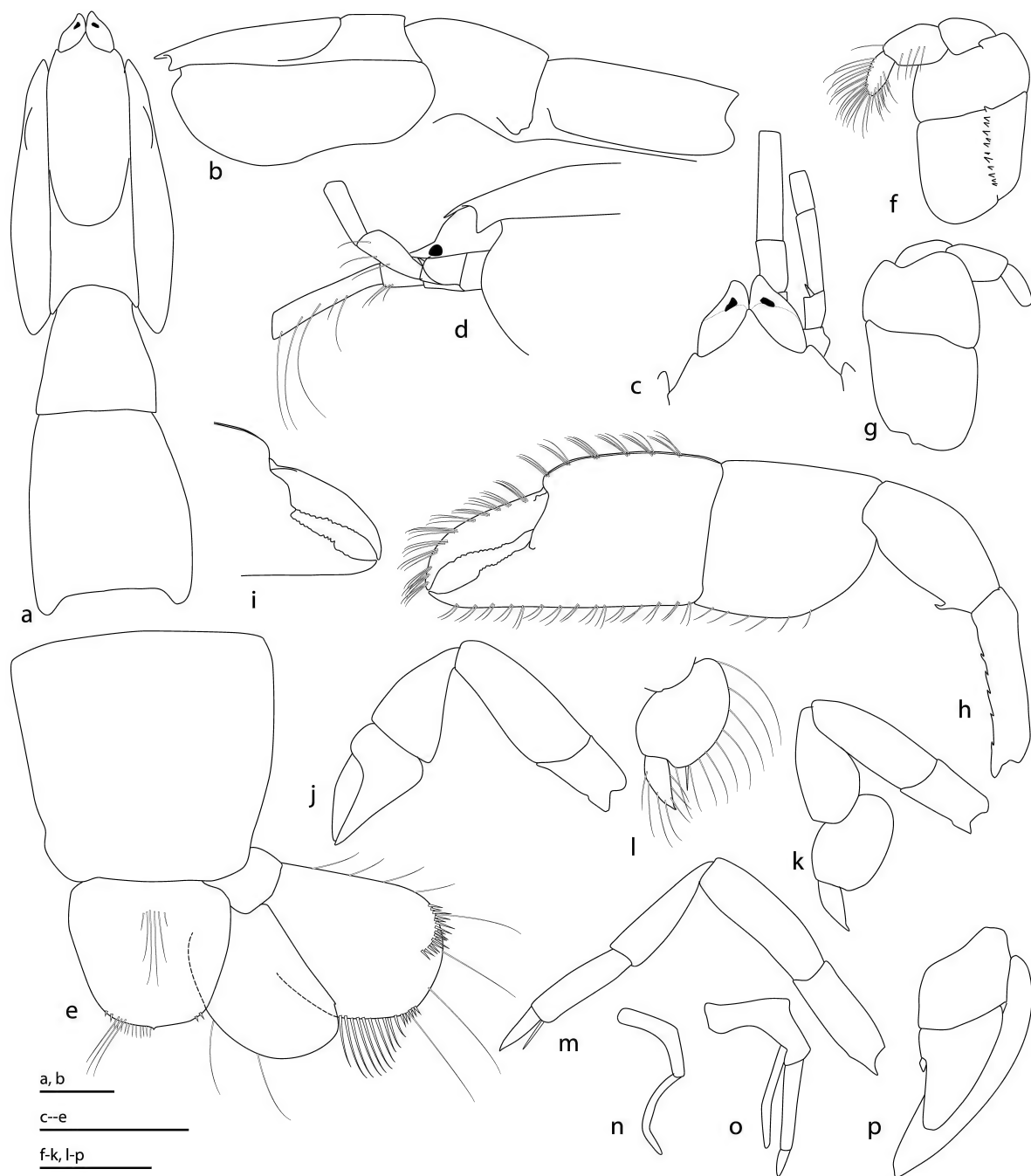


Figure 9. *Caviallianassa arafura* sp. nov. Australia, Arafura Sea, AM P74542, holotype ovigerous female, 3.5 mm. a, eyestalks, carapace, pleomeres 1, 2; b, carapace, pleomeres 1, 2; c, d, antennular, antennal peduncles, eyestalks, carapace (dorsal, lateral); e, pleomere 6, telson, right uropod; f, g, maxilliped 3 (outer, inner faces); h, major cheliped (right, mesial); i, major cheliped fingers (lateral); j, pereopod 2; k, pereopod 3; l, pereopod 3 propodus, dactylus; m, pereopod 4; n-p, pleopods 1-3. Scale bars = 1 mm.

as propodus upper margin. Pereopod 4 coxa flattened ventrally, immovable; merus 1.5 times as long as ischium; carpus 0.9 length of merus; propodus 0.8 length of carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with long spiniform setae parallel to dactylus; dactylus half as long as propodus.

Female pleopod 1 of 2 articles at right angles; peduncle with strong bend; ramus as long as peduncle. Female pleopod 2 biramous; peduncle bent; exopod 0.7 length of endopod; endopod of 2 articles, second 0.3 length of first. Pleopods 3–5 biramous, rami narrow; appendix interna slender, rod-like, projecting well beyond mesial margin of endopod, bearing coupling hooks on apical margin.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval, widest near midpoint, about 1.5 times as long as wide; anterior margin straight, with minute distal tooth; distal margin broadly convex, with fringe of setae; posterior margin setose. Exopod widest at midpoint, 1.25 times as long as wide; anterior margin straight; distoposterior margin evenly convex, with numerous slender setae, with about 12 blade-like setae indistinguishably merged with distal margin; upper surface without setae; dorsal plate extending about one third across exopod, with row of numerous stiff setae merging anteriorly with similar setae on distal margin.

Telson 1.1 times as wide as long, broadest at anterior third, tapering, with lateral and posterior margins continuous; posterior margin convex, with 2 sublateral pairs of spiniform setae, with median tooth.

**Etymology.** From the Arafura Sea, where the type specimen was collected (noun in apposition).

**Distribution.** Sahul Shelf; 140 m.

**Remarks.** *Cavillianassa arafura* resembles *C. cavifrons*, which was thoroughly described and figured by Komai and Fujiwara (2012) based on females from around 200 m depth in reducing sediments from Japan. The new species differs in the shorter, more tapering telson, the larger distal lobe on the merus of maxilliped 3 and the more elongated female major cheliped.

### *Cavillianassa moorea* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:979A1ED7-4734-428B-A119-A6754443E6DF>

Figures 1b, 10–12

*Cavillianassa* FP-11.—Poore et al., 2019: figs 3h, 6c, 8g, 10e, f, 11b, c.—Robles et al., 2020: figs 1, 3, 6.

*Cavillianassa* PNG-1165.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** Holotype. **French Polynesia**, Moorea, between Cook's Bay and Hilton, off Pihaena, 17.481° S, 149.8300° W (stn BIZ-632), UF 29204 (ovigerous female, 3.9 mm). Paratypes. Moorea, near Nihimaru river estuary, 17.535° S, 149.906° W (stn MB-216), UF 16481 (male, 3.0 mm), UF 16467\*# (ovigerous female, 3.1 mm). Papetoai, 17.49° S, 149.88° W, 0–3 m: stn BIZ-493, UF 28909\* (ovigerous female, 2.6 mm); stn BIZ-463, UF 28819\* (ovigerous female, 2.9 mm); stn BIZ-539, UF 28875\* (ovigerous female, 3.8 mm); stn BIZ-493, UF 28904\* (ovigerous female, 3.6 mm); stn BIZ-109, UF 23873# (ovigerous female, 3.8 mm); stn BIZ-109), UF 29097#

(ovigerous female, 3.8 mm). Other material. **Papua New Guinea**, Madang, near Rempi Mission, 5° 1.6' S, 145° 47.9' E, 2–15 m (PAPUA NIUGINI stn PR76), MNHN IU-2013-7092\*# (ovigerous female, 4.0 mm).

**Description.** *Female.* Rostrum triangular, blunt, flat, situated level with dorsal carapace, much shorter than eyestalks. Carapace dorsally flat, three quarters length of pleomeres 1, 2 combined; orbital margin almost transverse; anterolateral angle obtuse; subanterolateral margin weakly concave; anterior margin of branchiostegite with dorsal concavity; cervical groove deeply incised, across 0.8 length of carapace, reaching linea thalassinica. Pleomere 1 tergite with transverse groove, posterior half much wider than anterior half. Pleomere 2 1.1 times as long as wide. Pleomeres 3–5 each wider than long; pleura each with patch of plumose setae. Pleomere 6 about as long as wide, 1.1 times as long as pleomere 5, with obscure posterolateral groove.

Eyestalk about 2.5 times as long as wide, not concealed by rostrum, with lateral margin convex in dorsal view, anteromedial angle angular in dorsal view, reaching distal margin of antennular peduncle article 1. Cornea densely pigmented, occupying anterolateral-dorsal margin of eyestalk.

Antennular peduncle reaching beyond distal margin of antennal peduncle; article 1 not visible in dorsal view; article 3 about as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 0.8 times as long as article 4, reaching 0.7 length of antennal article 3; scaphocerite minute, oval.

Mandible molar process shelf-like, with small mesial teeth; incisor process with irregular teeth. Maxilliped 3 ischium dilating distally, 1.5 times as wide as long, crista dentata consisting of row of about 15 small, well-spaced sharp teeth; merus shorter than ischium, about twice as wide as long, with mesiodistal margin produced as convex lobe beyond base of carpus; carpus 0.7 times merus outer margin; propodus subrectangular, 1.2 times as long as wide; dactylus as long as propodus, with convex extensor (outer) margin, densely setose distally, with straight flexor (inner) margin bearing 3 or 4 setae.

Pereopods 1 (chelipeds) unequal, dissimilar. Female major cheliped massive, carpus-palm upper margin just exceeding carapace length. Ischium expanding distally, upper margin concave, unarmed; lower margin with 4 obsolete teeth. Merus as long as ischium, twice as long as wide, subrectangular; upper margin convex, unarmed; lower margin with 3 small subproximal teeth, with denticulate blade over third quarter. Carpus about as long as wide; margins carinate; upper margin smooth; lower margin convex. Propodus upper margin as long as carpus; palm of almost even width, 1.1 times as long as wide; upper margin carinate; lateral surface smooth, convex, with 4 clusters of long setae in gape; mesial surface slightly convex, with 2 denticles and 1 cluster of long setae at base of finger; lower margin carinate, with row of clusters of setae extending onto fixed finger; fixed finger 0.67 times as long as palm, not depressed, base 0.6 times length; cutting edge with finely denticulate blade along lateral margin. Dactylus overreaching fixed finger, with acute tip; upper margin with tufts of long setae; cutting edge finely denticulate over distal three quarters.

Minor cheliped carpus-palm upper margin 0.9 carapace length. Ischium margins smooth. Merus about as long as ischium; lower margin convex distally, unarmed. Carpus widest over distal half, 1.25 times as long as merus, twice as long as wide. Palm 1.25 times as long as wide; upper margin barely convex; lower margin sharply carinate, with row of long setae extending onto fixed finger; lateral face with cluster of

long setae at base of finger. Fixed finger deep, triangular, 0.7 length of palm, cutting edge denticulate except over distal third. Dactylus longer than palm, curved; cutting edge smooth.

Pereopod 2 merus lower margin slightly sinusoidal, twice as long as wide; carpus about 1.8 times as long as wide; chela subtriangular; palm about twice as wide as upper margin; dactylus 2.3 times as long as palm upper margin. Pereopod 3

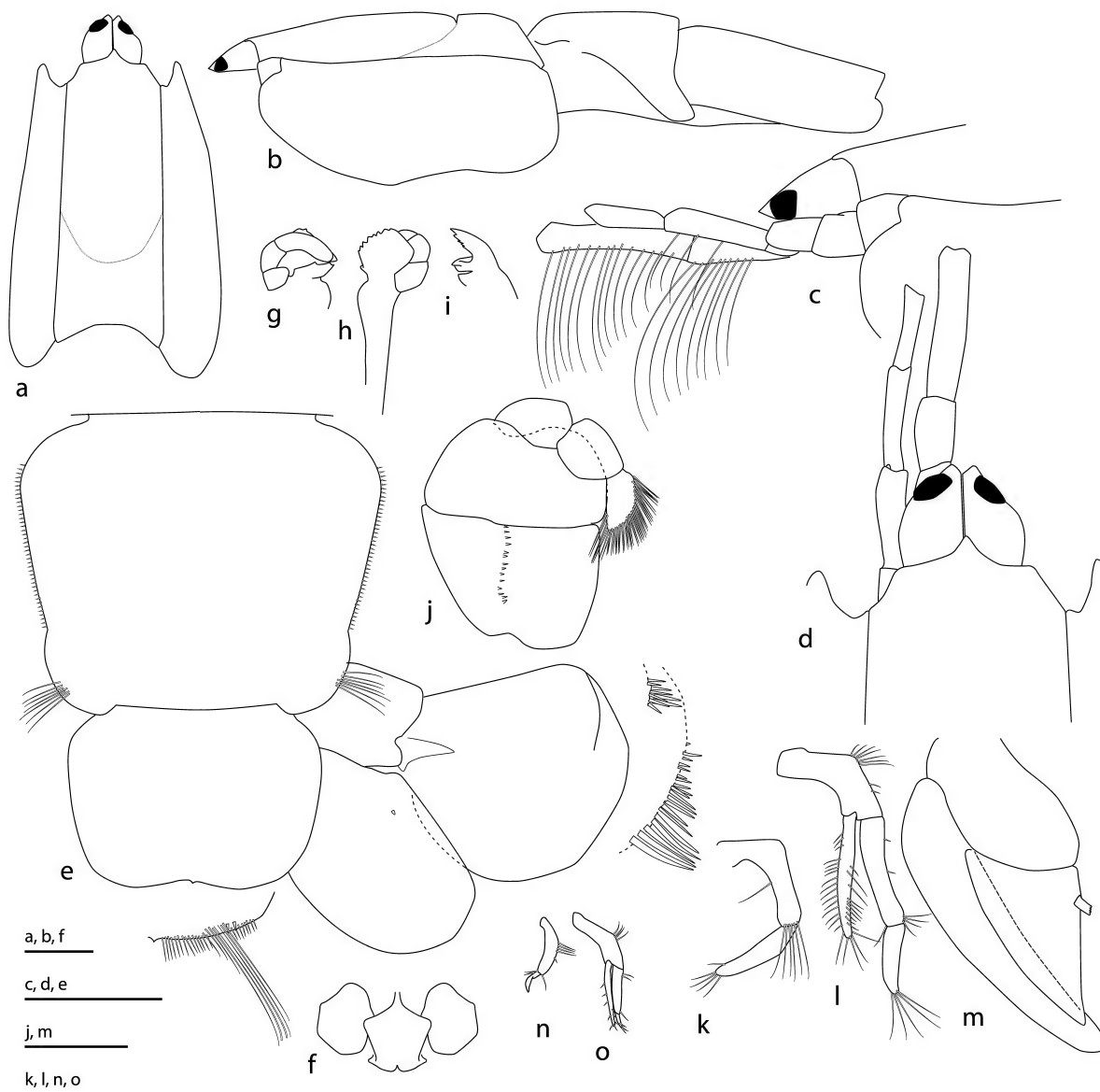


Figure 10. *Caviallianassa moorea* sp. nov. French Polynesia. UF 29204, holotype ovigerous female, 3.9 mm: a, carapace; b, carapace, pleomeres 1, 2; c, d, anterior carapace, eyestalks, antennular, antennal peduncles; e, pleomere 6, telson, right uropod (with detail of setation); f, thoracic sternum 7, coxae 4; g-i, mandible views; j, maxilliped 3; k-m, pleopods 1-3. UF 16481, paratype male, 3.0 mm: n, o, pleopods 1, 2. Scale bars = 1 mm.

carpus subtriangular, 1.7 times as long as wide; propodus subrectangular with broadly produced lower proximal margin, upper margin equal to greatest width, lower margin almost straight, with short subdistal spiniform seta; dactylus about as long as propodus upper margin. Pereopod 4 coxa flattened ventrally, immovable; merus 1.5 times as long as ischium;

carpus 0.9 length of merus; propodus 0.8 length of carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with long spiniform setae parallel to dactylus; dactylus half as long as propodus.

Female pleopod 1 of 2 articles at right angles; peduncle with strong bend; ramus half as long as peduncle. Female

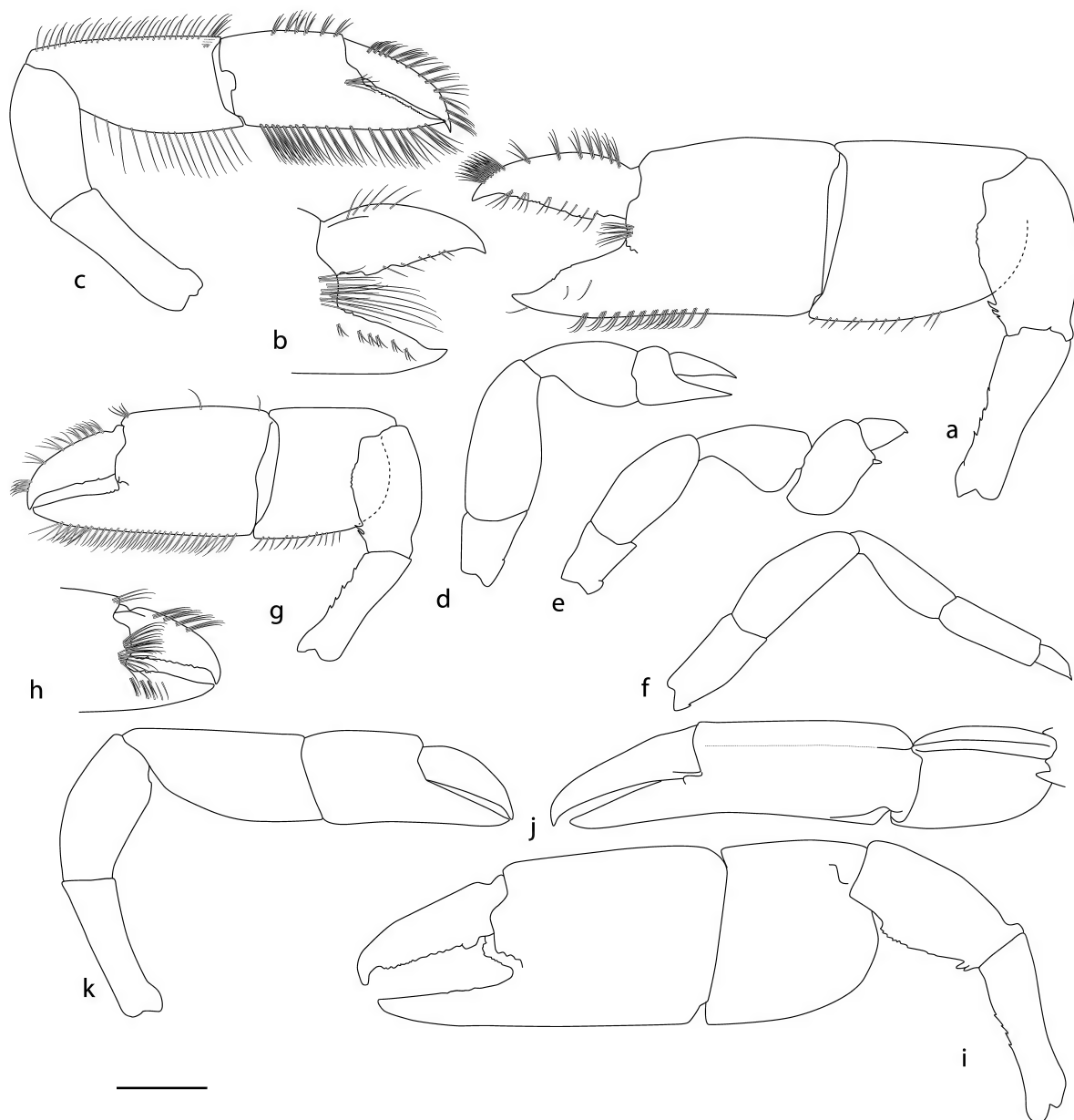


Figure 11. *Caviallianassa moorea* sp. nov. French Polynesia. UF 29204, holotype ovigerous female, 3.9 mm: a, major cheliped (right, mesial); b, major cheliped fingers (lateral); c, minor cheliped (left, mesial); d–f, pereopods 2–5. UF 16481, paratype male, 3.0 mm: g, major cheliped (right, mesial); h, major cheliped fingers (lateral). UF 29097, paratype ovigerous female, 4.0 mm: i, j, major cheliped (right, mesial, upper views); k, minor cheliped (left, mesial view). Scale bar = 1 mm.

pleopod 2 biramous; peduncle bent; exopod 0.7 length of endopod; endopod of 2 articles, second two-thirds length of first. Pleopods 3–5 biramous, rami narrow; appendix interna projecting well beyond mesial margin of endopod, bearing coupling hooks on apical margin.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval, widest near midpoint, about 1.3 times as long as wide; upper surface with 1 proximal spiniform seta; anterior margin straight; distal margin broadly convex, with fringe of setae; posterior margin setose. Exopod widest at midpoint, about as wide as long; anterior margin straight; posterior margin semicircular, with numerous slender setae, with more than 20 blade-like setae indistinguishably merged with distal margin; upper surface

without setae; dorsal plate extending about one third across exopod, with row of numerous stiff setae merging anteriorly with similar setae on distal margin.

Telson 1.4 times as wide as long, broadest at anterior third, with lateral and posterior margins continuous; posterior margin concave, with 2 sublateral pairs of spiniform setae, with median tooth.

*Male.* Major cheliped similar to that of female. Ischium lower margin with 6 irregular teeth. Merus lower margin with 3 subproximal teeth, with denticulate blade over third quarter. Propodus upper margin 1.15 times as long as carpus; palm of almost even width, 1.15 times as long as wide; lateral surface with 2 clusters of long setae in gape; mesial surface with 1 denticle and 1 cluster of long setae at base of finger; fixed finger

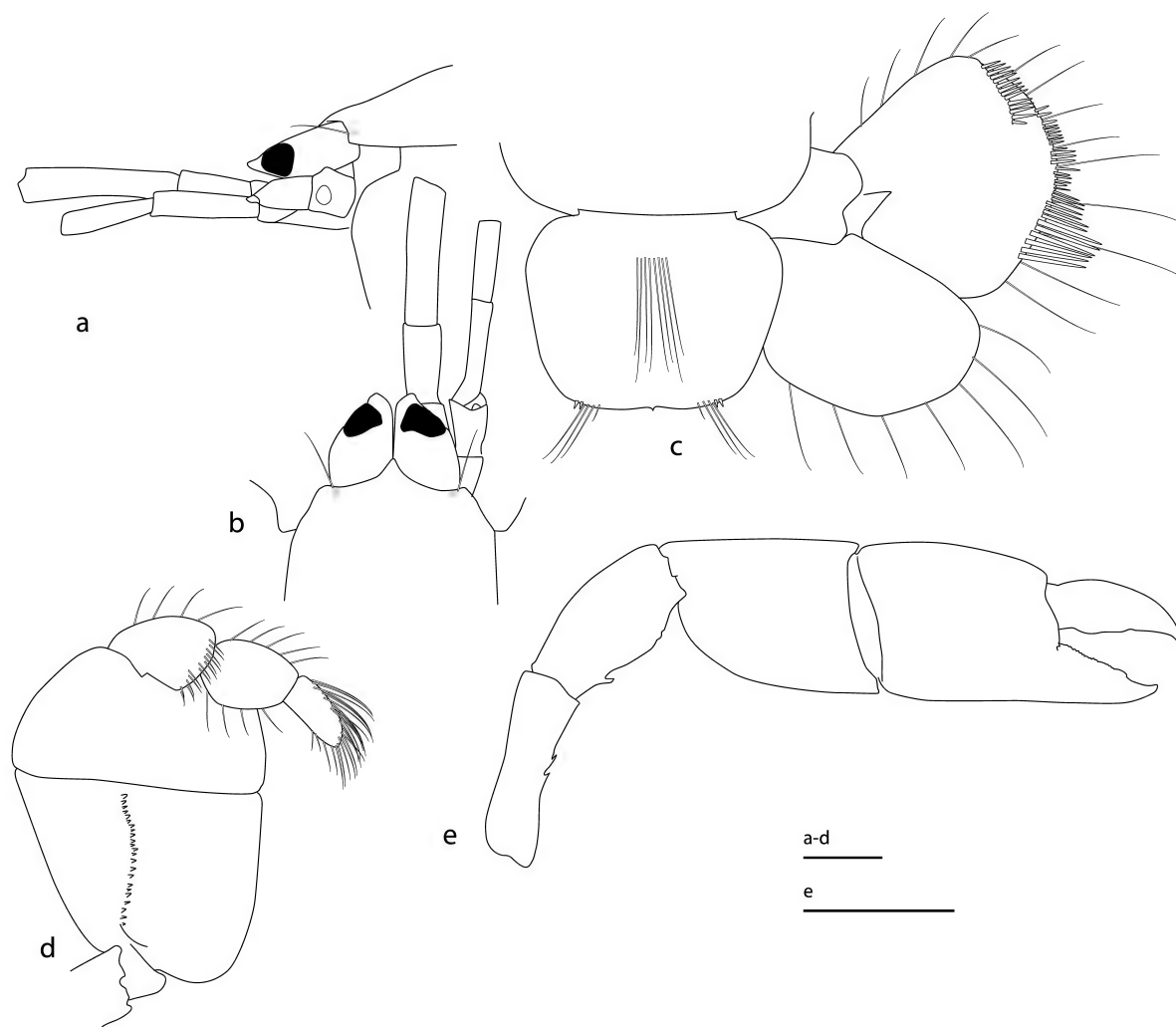


Figure 12. *Caviallianassa moorea* sp. nov. Papua New Guinea. MNHN IU-2013-7092, ovigerous female, 4.0 mm: a, b, anterior carapace, eyestalks, antennular, antennal peduncles (lateral, dorsal); c, telson, right uropod; d, maxilliped 3; e, major cheliped (left, mesial). Scale bars = 1 mm.



0.67 times as long as palm, not depressed, base half length; cutting edge mostly smooth.

Pleopod 1 of 2 articles; peduncle curved; ramus twisted, 0.4 length of peduncle. Pleopod 2 biramous; peduncle bent; exopod slightly shorter than endopod; endopod of 2 articles, second third length of first.

*Etymology.* From Moorea, where the type specimen was collected (noun in apposition).

*Distribution.* Southeast Polynesia, Eastern Coral Triangle (French Polynesia, Papua New Guinea); intertidal.

*Remarks.* Robles et al. (2020) found almost no genetic differences between four specimens of “C. FP-11” from Moorea in their molecular phylogram. Another, “C. PNG-1165” from Papua New Guinea was sister of these but more remote (0.036 divergence for the 12S gene) and may warrant recognition as a separate species. No meaningful morphological differences in the telson, uropod or antennae were detected between this ovigerous female (MNHN IU-2013-7092) and those from Moorea. The major cheliped (fig. 12e) is slightly more slender; the merus has one tooth rather than two or three but has the same tubercle in the gape. The cheliped, and other features, differ significantly from the only specimen of *Caviallianassa* from Papua New Guinea described below as another species.

#### *Caviallianassa riwo* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:24234C2A-B2AE-4D64-BB50-F11D8849A930>

Figures 13, 14

*Caviallianassa* PNG-1172.—Robles et al., 2020: figs 1, 3, 6.

*Material examined.* Holotype. **Papua New Guinea**, Madang, off Riwo, 5° 9' S, 145° 48.2' E, 1–2 m (PAPUA NIUGINI stn PR235), MNHN IU-2013-7111## (female, 2.5 mm).

*Description. Female.* Rostrum triangular, blunt, flat, situated level with dorsal carapace, shorter than half length of eyestalks. Carapace dorsally flat, 0.8 length of pleomeres 1–2 combined; orbital margin almost transverse, with pair of semicircular translucent area laterally; anterolateral lobes produced, rounded; subanterolateral margin straight; anterior margin of branchiostegite with dorsal concavity; cervical groove across 0.75 length of carapace, reaching linea thalassinica. Thoracic sternite 7 subpentagonal with slightly projecting anteromedian margin; ventral surface with shallow median groove. Pleomere 1 tergite with transverse groove, posterior half scarcely wider than anterior half. Pleomere 2 about as long as wide. Pleomeres 3–5 each wider than long; pleura each with patch of plumose setae. Pleomere 6 0.9 times as long as wide, 1.8 times as long as pleomere 5, with slight posterolateral notch.

Eyestalk about 1.3 times as long as wide, with dorsal face close to rostrum, anterolateral margin tapering, convex, oblique, anteromedial angle rounded in dorsal view, overreaching distal margin of antennular peduncle article 1. Cornea densely pigmented, occupying anterolateral margin of eyestalk.

Antennular peduncle reaching beyond distal margin of antennal peduncle; article 1 not visible in dorsal view; article 3

little longer than articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 0.7 times as long as article 4; scaphocerite minute, droplet-shaped.

Maxilliped 3 ischium dilating distally, 1.3 times as wide as long, crista dentata consisting of row of 9 small, well spaced teeth; merus 0.6 times as long as ischium measured along outer margin, about twice as wide as long, with mesiodistal margin produced as convex lobe beyond base of carpus; carpus 0.8 times as long as merus outer margin; propodus tapering over distal two-thirds, 1.2 times as long as wide, flexor (inner) margin with subproximal lobe; dactylus 0.8 times as long as propodus, with convex extensor (outer) margin, densely setose distally, with straight flexor (inner) margin bearing 4 setae.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped massive, carpus-palm upper margin 1.25 carapace length. Ischium expanding distally, upper margin concave, unarmed; lower margin with 3 teeth. Merus as long as ischium, 1.75 times as long as wide (tooth excluded), ovate; upper margin convex, carinate, with subproximal tubercle; lower margin with 2 subproximal teeth, with broad lobe beyond midpoint. Carpus 1.2 times as wide as long; margins carinate; upper margin smooth; lower margin convex. Propodus upper margin 1.5 times as long as carpus; palm widest subproximally, tapering, 1.1 times as long as wide; upper margin carinate; lateral surface smooth, convex, with concave gape, with cluster of long setae close to distal margin; mesial surface convex, with lobed ridge set back from distolateral margin; lower margin sharply carinate, with row of setae extending onto fixed finger; fixed finger 0.5 times as long as palm, curved upwards; cutting edge, concave, smooth. Dactylus overreaching fixed finger, strongly hooked distally; upper margin with tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge with 2 large blunt teeth.

Minor cheliped carpus-palm upper margin 1.05 carapace length. Ischium upper margin smooth, lower margin with 1 small spine. Merus 0.8 times as long as ischium; margins smooth. Carpus parallel-sided over most of length, 1.3 times as long as merus, 2.3 times as long as wide. Palm rectangular, 1.4 times as long as wide; upper margin barely convex; lower margin carinate, with row of long setae extending onto fixed finger. Fixed finger triangular, 0.6 times as long as palm, cutting edge denticulate over middle third. Dactylus as long as palm, curved; cutting edge smooth.

Pereopod 2 merus lower margin slightly sinusoidal, 2.15 times as long as wide; carpus 1.5 times as long as wide; chela subtriangular; palm twice as wide as upper margin; dactylus twice as long as palm upper margin. Pereopod 3 carpus subtriangular, 1.8 times as long as wide; propodus almost semicircular, wider than long, with strongly produced evenly-curved lower margin, marginal setae clustered, with 1 slender spiniform seta; dactylus about as long as propodus upper margin. Pereopod 4 coxa flattened ventrally, immovable; merus 1.25 times as long as ischium; carpus as long as merus; propodus 0.8 times as long as carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with long spiniform setae parallel to dactylus, almost

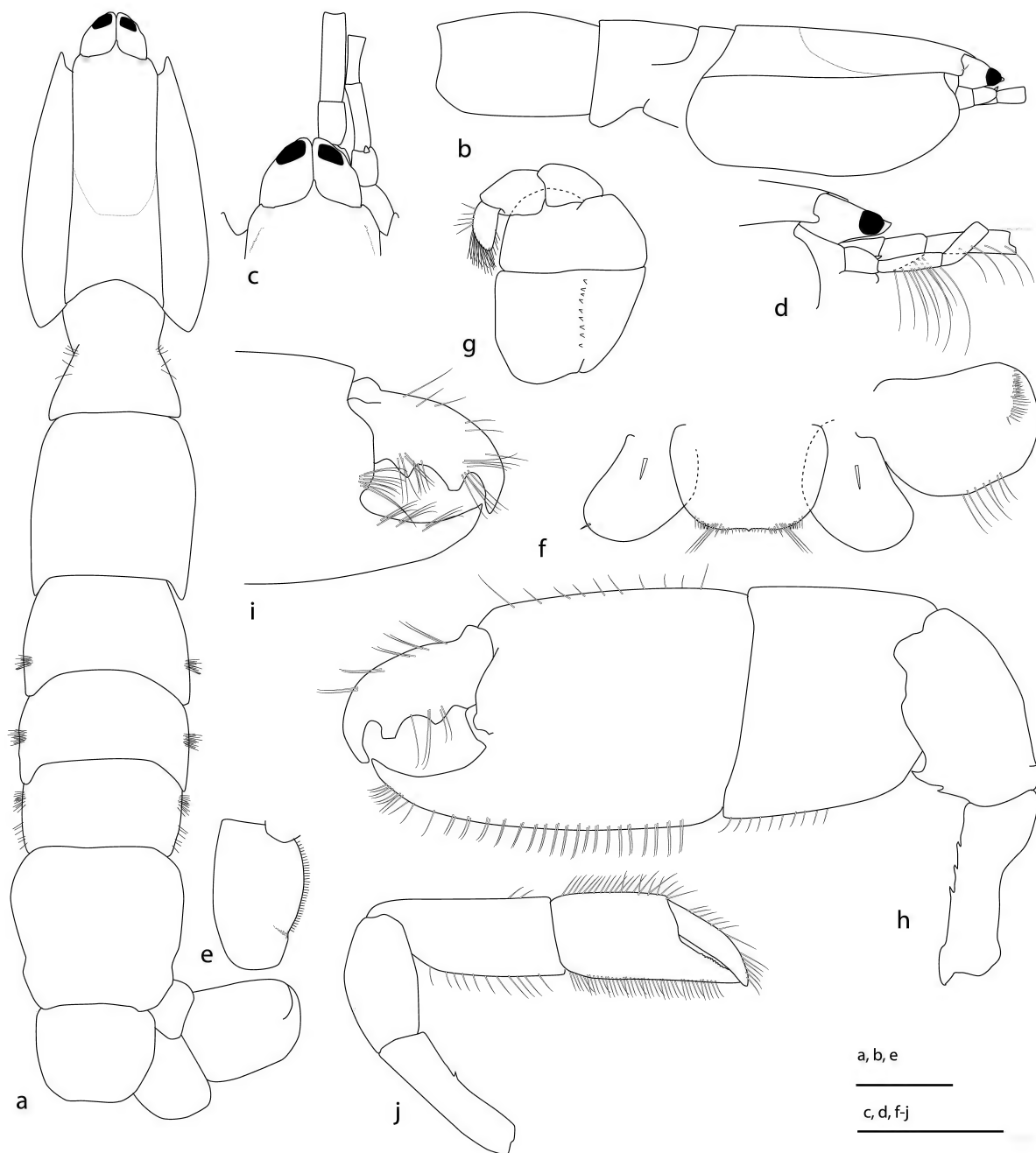


Figure 13. *Caviallianassa riwo* sp. nov. Papua New Guinea. MNHN IU-2013-7111, holotype female, 2.5 mm: a, carapace, pleon, telson, uropod; b, carapace, pleomeres 1, 2; c, d, antennular, antennal peduncles, eyestalks, carapace front; e, pleomere 6, right lateral; f, telson, right uropod, left uropod endopod; g, maxilliped 3; h, major (left) cheliped; i, major cheliped fingers, lateral; j, minor (left) cheliped. Scale bars = 1 mm.

reaching tip; dactylus half as long as propodus. Pereopod 5 slender, with chela about as long as carpus, slightly curving, fixed finger with short subdistal spiniform setae.

Pleopod 1 of 2 articles; ramus shorter than peduncle, with 2 distal setae. Pleopod 2 biramous; peduncle bent; exopod 0.7 times as long as endopod; endopod of 2 articles. Pleopods 3–5 biramous, endopod 1.5 times as long as wide; appendix interna twice as long as wide, projecting well beyond mesial margin of endopod, bearing coupling hooks on apical margin.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval, widest proximally, about as long as wide; upper surface with 1 long spiniform seta; anterior margin slightly convex; margins setose. Exopod widest at midpoint, 1.3 times as long as wide, exceeding endopod by about half its length; anterior margin concave; posterior margin with 6 or 7 blade-like setae indistinguishably merged with distal margin; upper surface without setae; dorsal plate extending about halfway across exopod, comprising about 30 stiff setae merging anteriorly with similar setae on distal margin.

Telson trapezoidal, 1.4 times as wide as long, broadest at anterior third, narrowing posteriorly to evenly rounded posterolateral corners; posterolateral angle with 2 short spiniform setae; posterior margin with median tooth.

**Etymology.** From Riwo, Papua New Guinea, a village near the type locality (noun in apposition).

**Distribution.** Eastern Coral Triangle (Papua New Guinea); 1–2 m.

**Remarks.** The species is known from a single female well separated from *Caviallianassa moorea* in Robles et al.'s (2020) molecular phylogram. The antennae are relatively more compact than in *C. moorea*. Although the female is smaller than those of *C. moorea*, the major cheliped has more developed dentition on the fingers; the bifid meral tooth is more prominent than the two small teeth seen in *C. moorea*, approaching that seen in *C. cavifrons* (Komai and Fujiwara, 2012).

### ***Cheramus* Bate, 1888**

*Cheramus* Bate, 1888: 29.—Poore et al., 2019: 93 (redagnosis, synonymy).—Poore and Ah Yong, 2023: 212.

**Remarks.** The type species of *Cheramus* was selected by Manning and Felder (1991) as *Cheramus occidentalis* Bate, 1888, now *C. profundus* (Biffar, 1973). As Sakai (2005) pointed out, this subsequent type species designation predated by one day that by Holthuis (1991) of *Cheramus orientalis* Bate, 1888. *Cheramus profundus* is a West Atlantic species and the only member of the genus (Poore et al., 2019). Lacking molecular data, Robles et al. (2020) and Poore et al. (2019) relied on morphology to place the genus close to *Cheramoides* Sakai, 2011 and *Poti* Rodrigues and Manning, 1992, two other monotypic West Atlantic genera. The antennular peduncle is exceeded by all of the antennal peduncular article 5 and the minor and major chelipeds are similar, both attenuated, with swollen palms (Biffar, 1973). *Cheramus* has been widely used as a genus or subgenus name for small callianassids in the Indo-West Pacific. Sakai (2011) included 16 species and others have been added since (Komai and Fujiwara, 2012; Komai et al., 2014b; Sepahvand et al., 2015). Komai et al. (2014b) reviewed use of the genus name but *Cheramus* does not occur in the Indo-West Pacific.

### ***Coriollianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019**

*Coriollianassa* Poore et al., 2019: 93.—Robles et al., 2020: figs 1, 3, 6.—Poore and Ah Yong, 2023: 212.

**Remarks.** The genus is characterised by the sharp anteriorly directed rostrum with a dorsal carina. The antennal peduncle is longer than the antennular peduncle and the scaphocerite is usually bifid. The carpus of the larger cheliped has an unusual “neck” such that the merus does not overlap the carpus at right angles as in many callianassids. The lower margin of merus of the cheliped has an oblique tooth with a minute tooth more

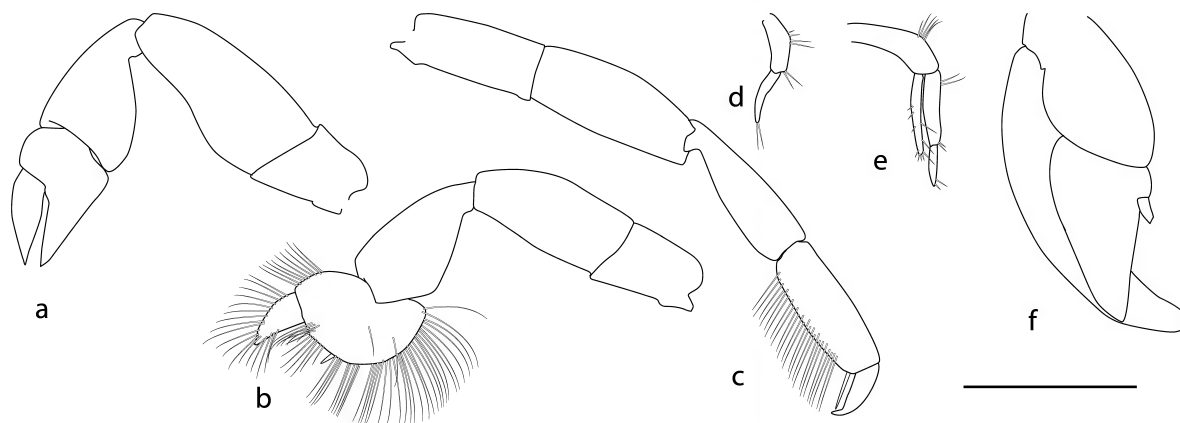


Figure 14. *Caviallianassa riwo* sp. nov. Papua New Guinea. MNHN IU-2013-7111, holotype female, 2.5 mm: a–c, pereopods 2–4; d–f, pleopods 1–3. Scale bar = 1 mm.

proximal. The eyestalk is well domed above the cornea. Contrary to Poore et al.'s (2019) diagnosis, the male pleopod 2 is a small tubercle; pleopod 1 is a simple ramus.

The molecular phylogeny (Robles et al., 2020) recognised four clades, some with little support: (1) *Coriollianassa* MOZ-33, five individuals from the Mozambique Channel; (2) one individual from Vanuatu; (3) a specimen identified as *C. coriolisae* (Ngoc-Ho, 2014) from its type locality, the Philippines; and (4) *C. MOZ-31*, another specimen from the Mozambique Channel. These are treated here as *C. coriolisae* and two new species. The identity of additional material from northwestern Australia previously identified as *C. sibogae* (De Man, 1905) was confirmed but other material from this region was found to belong to a third new species. Differences between species can be found in the shapes of the eyestalks, rostrum, maxilliped 3, pleomere 1 and in proportions of pleomere 6, telson and the uropodal rami.

The identity of another from French Polynesia identified as *C. sibogae* remains in doubt.

### *Coriollianassa coriolisae* (Ngoc-Ho, 2014)

Figure 15

*Callianassa coriolisae* Ngoc-Ho, 2014: 552–554, fig. 3 (type locality, Philippines).

*Coriollianassa coriolisae*.—Poore et al., 2019: 93, 137, 142, fig. 2n.—Robles et al., 2020: figs 1, 3, 6, Supplementary tables 1, 2.

**Material examined.** **Philippines.** N Sulu Sea, 11° 58' N, 121° 15' E, 320–337 m (MUSORSTOM 3 stn CP119), MNHN IU-2013-18276 (holotype of *Callianassa coriolisae*, male, 12 mm). Casiguran Sound, 16° 5' N, 121° 57' E, 98–107 m (MNHN AURORA stn 2654), NMCR 49805 (ULLZ 10135\*), (male without major cheliped, 6.4 mm). Off Dipaculao, 15° 57' N, 121° 47' E, 278–271 m (AURORA stn CC2733), NHMW 26457 (male, 6.9 mm, figured by P.C. Dworschak, pers. comm.). **Vanuatu**, S of Espiritu Santo, 15° 43' S, 167° 03' E, 441 m (SANTO Casier 3), MNHN IU-2013-7138\* (female, 6.5 mm, without chelipeds).

**Diagnosis.** Rostrum scarcely carinate dorsally, with ventral keel-like carina. Maxilliped 3 merus with broadly rounded mesiodistal angle. Telson elongate-trapezoidal, 1.4 times as long as wide.

**Distribution.** Western Coral Triangle (type locality: N Sulu Sea, 320–337 m), Tropical Southwestern Pacific; 98–441 m.

**Remarks.** *Callianassa coriolisae* was well illustrated by Ngoc-Ho (2014). Here, the carapace of the holotype is illustrated in dorsal and lateral views along with detail of the front and antennae. Ngoc-Ho separated the new species from *C. sibogae* on the absence of a rostral carina, more oblique distomesial margin of the maxillipedal merus, and shape of the uropod. The fragmentary material from the Philippines, illustrated by Peter C. Dworschak (pers. comm.), and from Vanuatu, illustrated here (fig. 15c, d), are included with some hesitation in *C. coriolisae*. All specimens are no more than half the size of the holotype of *C. coriolisae*. One specimen from each locality was sequenced but there was zero divergence between the two 12S sequences. All possess a maxilliped 3 merus with an oblique distomesial margin and a rostrum barely carinate above.

### *Coriollianassa mainbazeae* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:E1B2D755-3C57-4036-84C1-01C4C7BB5DC7>

Figures 16, 17

*Trypaea sibogae*.—Sakai and Türkay, 2012: 738–740, fig. 7 (Gulf of Aden).

*Coriollianassa* MOZ-33.—Poore et al., 2019: fig. 8c.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** Holotype. **Mozambique**, off Maputo, 25° 59' S, 34° 35' E, 630–638 m (MAINBAZA stn CC3173), MNHN IU-2008-10314\* (male, 8.0 mm). Paratypes. Collected with holotype, MNHN IU-2008-10315\* (female, 7.7 mm). Mozambique, off Maputo, 25° 36' S, 33° 17' E, 437–445 m, (MAINBAZA stn CC3172); MNHN IU-2008-7922\* (female, 8.8 mm); MNHN IU-2016-8146\* (female, 6.3 mm). Off Bazaruto I., 21° 36' S, 35° 57' E, 990–996 m (MAINBAZA stn CC3147), MNHN IU-2010-7924 (female, 7.3 mm).

**Diagnosis.** Rostrum with dorsal basal carina, with ventral straight keel-like carina. Maxilliped 3 merus with distinct oblique mesiodistal margin. Telson elongate-trapezoidal, 1.25 times as long as wide.

**Description of male holotype.** Rostrum laterally compressed, situated well below upper level of carapace, with dorsal basal carina, with ventral straight keel-like carina. Carapace convex anteriorly in lateral view, as long as pleomeres 1–3 combined; orbital margin concave; anterolateral angle produced slightly anteroventrally as narrow lobe; subanterolateral margin slightly convex, anterior margin of branchiostegite set well back, almost vertical; cervical groove across 0.75 length of carapace, almost reaching linea thalassinica. Pleomere 1 tergite waisted in dorsal view, with deep saddle visible in lateral view; posterior section flat in lateral view. Pleomere 2 widest, wider than long. Pleomeres 3–5 each wider than long; pleura each with patch of plumose setae. Pleomere 6 about as long as wide, 1.2 times as long as pleomere 5, with slight ventrolateral projection.

Eyestalk 1.2 times as long as wide, with oblique dorsal face diverging from rostrum, with sharp ventrolateral margin, anterolateral margin oblique, anteromedial angle rounded in dorsal view, not reaching distal margin of antennular peduncle article 1. Cornea with weak scattered pigmentation.

Antennular peduncle reaching to about distal margin of antennal peduncle article 4; article 1 clearly visible in dorsal view; article 2 shorter than article 1; article 3 1.4 times as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of sparse long setae. Antennal peduncle article 5 0.6 length of article 4; scaphocerite with bifid apex.

Mandible molar process shelf-like, with small mesial tooth; incisor process with obsolete teeth. Maxilliped 3 ischium tapering, twice as long as wide, crista dentata comprising row of about 18 strong, irregular, erect spines, stronger distally, overlapping distal margin; merus about 0.7 times as long as ischium measured along outer margin, about 1.4 times as wide as long, as wide as ischium, with distinct oblique mesiodistal margin; carpus shorter than merus; propodus ovoid, 1.7 times as long as wide; dactylus digitiform, 0.75 times as long as propodus.

Pereopods 1 (chelipeds) unequal, dissimilar. Male major cheliped massive, carpus-palm upper margin 1.1 times

carapace length. Ischium expanding distally, upper margin sinuous, unarmed; lower margin with row of 7 spines. Merus as long as ischium, twice as long as wide (tooth excluded), tapering distally; upper margin convex, unarmed; lower margin with oblique spine bearing a subproximal minute tooth, plus row of small tubercles distal to spine. Carpus 1.3 times as long as wide, with constricted “neck”; margins carinate; upper margin smooth, concave over proximal third; lower margin convex, with distal sharp tooth. Propodus upper margin as long as carpus; palm subquadrate, 1.2 times as long as wide; upper margin carinate; lateral surface smooth, convex, with peg-like tooth in gape; mesial surface slightly convex, with peg-like tooth in gape set back from lateral peg; lower margin carinate, with row of setae extending onto fixed

finger; fixed finger 0.8 times as long as palm, slightly depressed; cutting edge smooth, with obtuse blade at midpoint. Dactylus reaching as far as fixed finger, strongly curved distally, with acute tip; upper margin with tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge with rounded teeth diminishing distally; mesial surface with tufts of setae along cutting edge.

Minor cheliped slender; carpus-palm upper margin 0.7 carapace length. Ischium upper margin smooth, lower margin with row of 5 spines. Merus about as long as ischium; lower margin with spine near midpoint. Carpus 1.4 times as long as merus, parallel-sided over most of length, 4 times as long as wide. Palm slightly swollen, 1.3 times as long as wide; upper margin convex; lower margin sharply carinate, with row of long

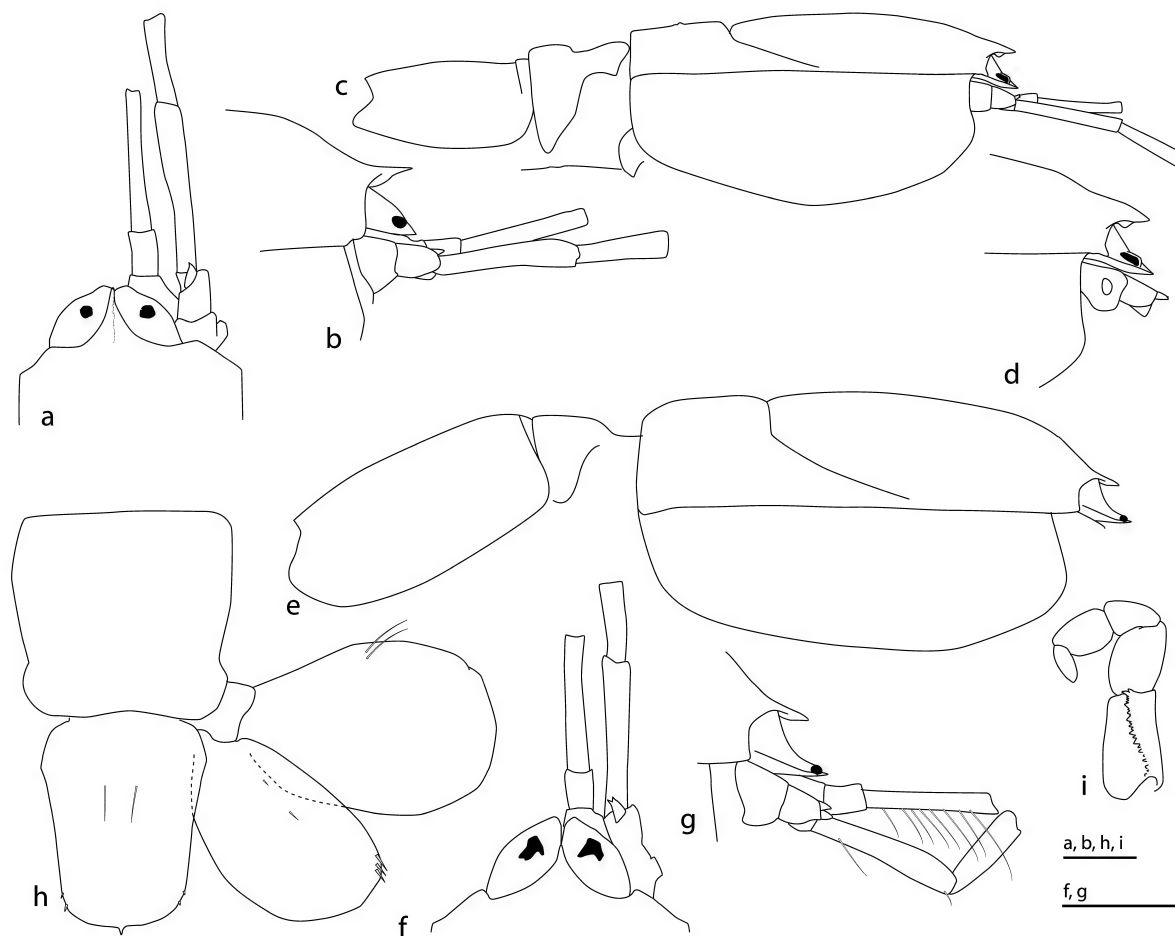


Figure 15. *Coriollanassa coriolisae* (Ngoc-Ho, 2014). Philippines, MNHN IU-2013-18276, holotype male, 12 mm: a, b, anterior carapace, eyestalk, antennular, antennal peduncles (dorsal, lateral views). NMCR 49805 (ULLZ 10135), male without major cheliped, 6.4 mm (from sketches supplied by P.C. Dworschak: c, eyestalk, antennular, antennal peduncles, carapace, pleomeres 1, 2; d, anterior carapace, eyestalk, antennal peduncle, Vanuatu, MNHN IU-2013-7138, female, 6.5 mm: e, carapace, pleomeres 1, 2; f, g, anterior carapace, eyestalk, antennular, antennal peduncles (dorsal, lateral views); h, pleomere 6, right uropod; i, maxilliped 3. Scale bars = 1 mm.

setae extending onto fixed finger. Fixed finger about as long as palm, slightly curving down; cutting edge smooth. Dactylus 1.6 times as long as palm, curved; cutting edge smooth.

Pereopod 2 merus lower margin slightly sinuoidal, 3.0 times as long as wide; carpus about twice as long as wide; chela subtriangular; palm about twice as wide as upper margin; dactylus 3 times as long as palm upper margin. Pereopod 3 carpus subtriangular, 2.6 times as long as wide; propodus suboval with produced lower proximal margin, upper margin 1.4 times width, lower margin convex, faintly undulate, marginal setae clustered on prominences, with 1 slender spiniform seta subdistally; dactylus about 0.9 times as

long as propodus upper margin. Pereopod 4 merus as long as ischium; carpus 0.8 length of merus; propodus 0.8 times as long as carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with spiniform seta parallel to dactylus; dactylus half as long as propodus. Pereopod 5 slender, with chela about as long as carpus, slightly curving; dactylus as long as fixed finger.

Male pleopod 1 uniarticulate, 8 times as long as wide, with few distal short setae. Pleopod 2 tubercle-like. Pleopods 3–5 biramous, rami narrow; appendix interna slender, rod-like, projecting well beyond mesial margin of endopod, bearing coupling hooks on apical margin.

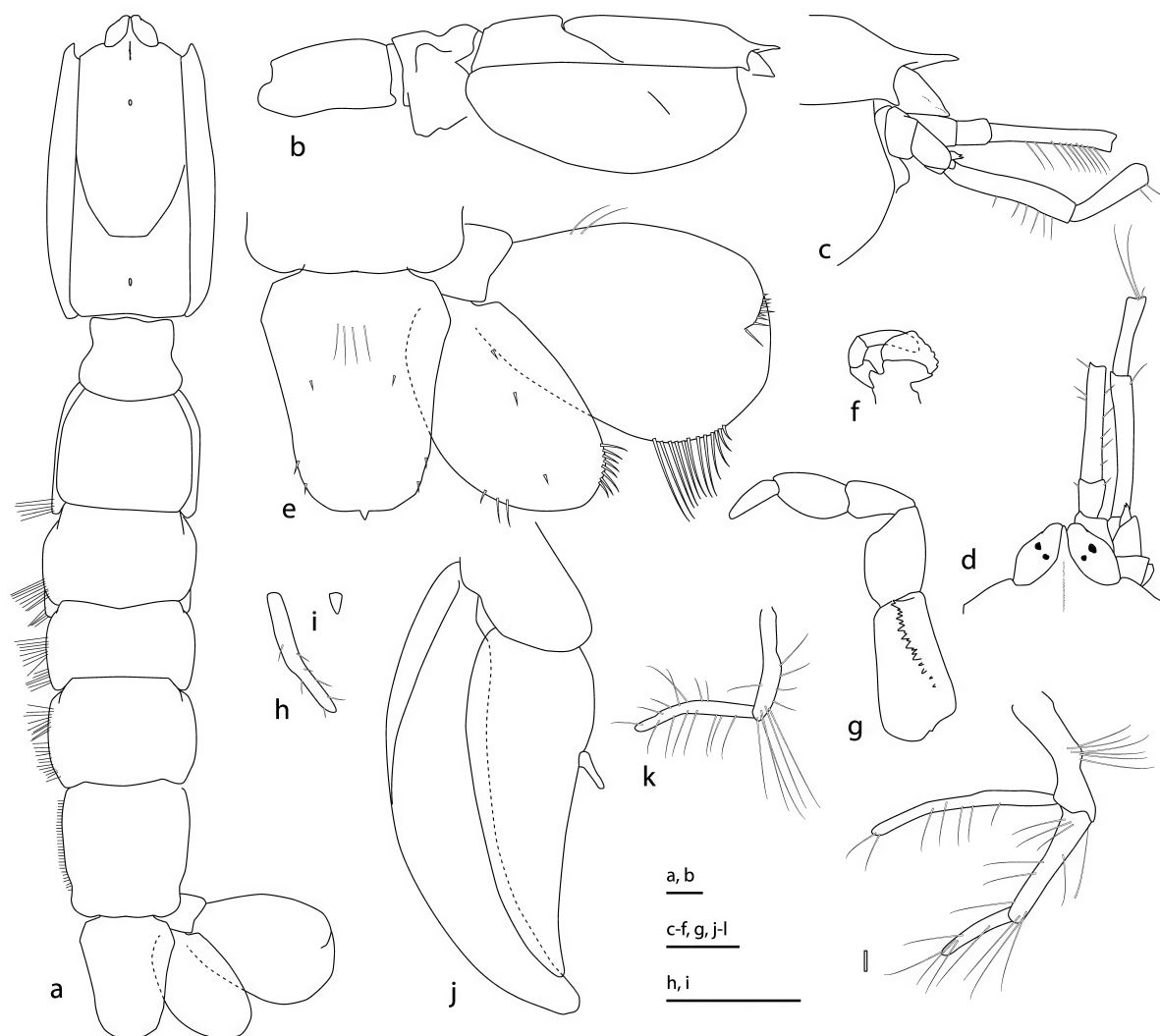


Figure 16. *Coriollanassa mainbazeae* sp. nov. Mozambique. MNHN IU-2008-10314, holotype male, 8.0 mm: a, eyestalks, carapace, pleon, telson, right uropod; b, carapace, eyestalk, pleomeres 1, 2; c, d, anterior carapace, eyestalk, antennular, antennal peduncles (lateral, dorsal views); e, telson, right uropod; f, mandible; g, maxilliped 3; h–j, pleopods 1–3. MNHN IU-2008-7922, paratype female, 8.8 mm: k, l, pleopods 1, 2. Scale bars = 1 mm.

Uropodal endopod and exopod overreaching posterior margin of telson. Endopod oval, about 1.6 times as long as wide; anterior margin slightly convex; anterodistal margin with 8 spiniform setae; distal margin convex, with fringe of setae; posterior margin with 3 stouter marginal setae; upper surface with row of up to 3 spiniform setae. Exopod dilating to rounded distal margin, 1.4 times as long as wide, exceeding endopod by about one fifth length; anterior margin convex, setose; posterior margin with numerous slender setae, with about 12 blade-like setae, indistinguishably merged with distal margin; upper surface with 1 or 2 submarginal slender setae about one third along; dorsal plate curved, short, about one third exopod width, with row of about 12 stiff setae distinct from setal row of distal margin.

Telson elongate-trapezoidal, 1.25 times as long as wide, broadest at anterior fifth, narrowing posteriorly; greatest width 1.7 times posterior width; dorsal surface with few medial setae anterior to midlength; lateral margin with 2 well-spaced spiniform setae near posterolateral angle; posterior margin convex, with median tooth.

*Female.* Major cheliped similar to male cheliped, carpus and palm more elongate; carpus 1.5 times as long as wide; propodus palm 1.4 times as long as wide. Minor cheliped similar to male. Pleopod 1 of 2 articles at right angles; ramus slightly longer than peduncle; setose (of single article in small female). Female pleopod 2 biramous; peduncle almost straight; exopod tapering distally, slightly shorter and narrower than endopod; endopod of 2 articles.

*Etymology.* For MAINBAZA, the survey of the coast of Mozambique in 2009 organised by the Instituto Español de Oceanografía and the Muséum national d'Histoire naturelle.

*Distribution.* Western Indian Ocean; 437–996 m.

*Remarks.* *Coriollanassa mainbazeae* has a longer and more tapering telson than other species of this genus. The rostrum is narrower and more acute in lateral view than in other species and is weakly carinate only on the carapace proper. Sakai and Türkay (2012) recorded and figured “*Trypaea sibogae*” from 472–479 m in the Gulf of Aden. The elongate pleomere 6 and telson plus geographic proximity suggest their record could be of *C. mainbazeae*.

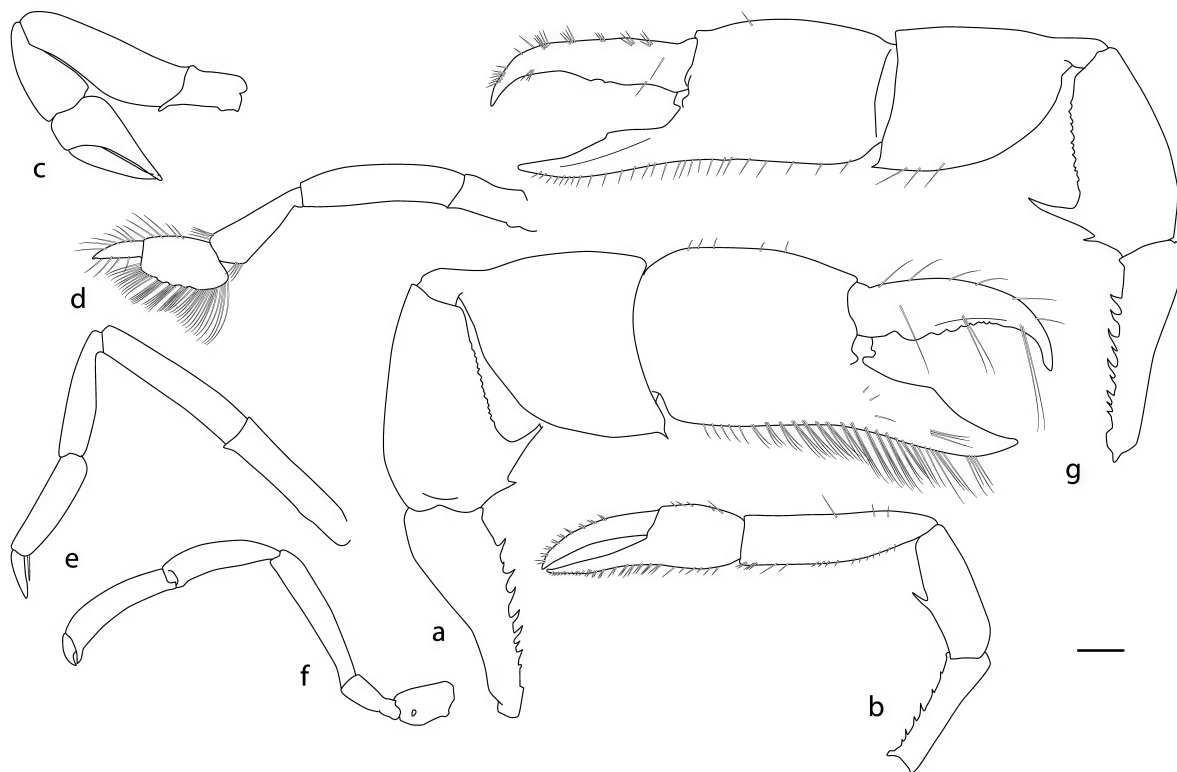


Figure 17. *Coriollanassa mainbazeae* sp. nov. Mozambique. MNHN IU-2008-10314, holotype male, 8.0 mm: a, major cheliped (left, mesial); b, minor cheliped (right, mesial); c–f, pereopods 2–5. MNHN IU-2008-7922, paratype female, 8.8 mm: g, major cheliped (right, mesial). Scale bar = 1 mm.

*Coriollianassa maputo* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:3750203A-DEF7-42CC-841E-1B7BC2DA693A>

Figure 18

*Coriollianassa* MOZ-31.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** Holotype. **Mozambique**, off Maputo, 25° 59' S, 34° 35' E, 638 m (MAINBAZA stn CC3172), MNHN IU-2014-10472\* (female, 3.9 mm, without chelipeds, pereopod 3).

**Diagnosis.** Rostrum carinate dorsally, with ventral keel-like carina. Maxilliped 3 merus truncate distally, with sharply rounded mesiodistal angle. Pleomere 1 tergite with dome-like posterior section. Telson trapezoidal, 0.8 times as long as wide.

**Description of female holotype.** Rostrum laterally compressed, deep, situated well below upper level of carapace, exceeding eyestalks, with sharp dorsal carina, with ventral convex keel-like carina. Carapace convex anteriorly in lateral view, as long as pleomeres 1–3 combined; orbital margin oblique-transverse; anterolateral angle scarcely produced, rounded; subanterolateral margin straight, anterior margin of branchiostegite set well back, almost vertical; cervical groove across 0.8 length of carapace, almost reaching linea thalassinica. Pleomere 1 tergite waisted in dorsal view, with deep saddle visible in lateral view; posterior section domed in lateral view. Pleomere 2 widest, wider than long, laterally flared. Pleomeres 3–5 each wider than long; pleura each with patch of plumose setae. Pleomere 6 1.25 times as long as wide, 1.3 times as long as pleomere 5, with slight ventrolateral projection.

Eyestalk 0.7 long as wide, with transverse distal margin bearing convex protruding cornea, well short of distal margin of antennular peduncle article 1. Cornea dome-shaped, well pigmented.

Antennular peduncle reaching to about distal margin of antennal peduncle article 4; article 1 clearly visible in dorsal view; article 2 shorter than article 1; article 3 as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of sparse long setae. Antennal peduncle article 5 0.6 length of article 4; scaphocerite with bifid apex.

Mandible molar process shelf-like, with small mesial tooth; incisor process with obsolete teeth. Maxilliped 3 ischium tapering, 2.2 times as long as wide, crista dentata comprising row of about 15 strong, irregular, erect spines, stronger distally, overlapping distal margin; merus about 0.6 times as long as ischium measured along outer margin, about 0.6 as wide as long, widest distally, with distinct transverse distal margin; carpus shorter than merus; propodus ovoid, 1.7 times as long as wide; dactylus digitiform, 0.75 times as long as propodus.

Pereopods 1 (chelipeds) missing.

Pereopod 2 merus lower margin slightly sinusoidal, 4.0 times as long as wide; carpus about 1.8 times as long as wide; chela subtriangular; palm about 0.17 times width of upper margin; dactylus 2.7 times as long as palm upper margin. Pereopod 4 merus 1.4 times as long as ischium; carpus 0.65 length of merus; propodus as long as carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with spiniform seta parallel to dactylus;

dactylus half as long as propodus. Pereopod 5 slender, with chela longer than carpus, slightly curving; dactylus longer than fixed finger.

Female pleopod 1 uniaarticulate, with subdistal setae. Pleopod 2 biramous. Pleopods 3–5 biramous, rami narrow; appendix interna slender, rod-like, projecting well beyond mesial margin of endopod, bearing coupling hooks on apical margin.

Uropodal endopod and exopod overreaching posterior margin of telson. Endopod oval-tapering, about 1.7 times as long as wide; anterior margin slightly convex; anterodistal margin without spiniform setae; distal margin convex, with fringe of setae; posterior margin without stouter marginal setae; upper surface without spiniform setae. Exopod dilating to rounded distal margin, 1.7 times as long as wide, exceeding endopod by about one quarter length; anterior margin convex, setose; posterior margin with numerous slender setae, with about 12 blade-like setae, indistinguishably merged with distal margin; upper surface with 1 submarginal slender seta about one third along; dorsal plate curved, short, about one fifth exopod width, with row of about 12 stiff setae distinct from setal row of distal margin.

Telson trapezoidal, 0.8 times as long as wide, broadest at anterior 0.2, narrowing posteriorly; greatest width 1.6 times posterior width; dorsal surface with few medial setae anterior to midlength; posterolateral angle with 1 spiniform seta; posterior margin convex, without median tooth.

**Etymology.** For Maputo, a town in Mozambique close to the type locality (noun in apposition).

**Distribution.** Western Indian Ocean; 638 m (known only from type locality).

**Remarks.** Four features distinguish *Coriollianassa maputo* from *C. mainbazeae*, the other species from the Mozambique Channel: (1) the strongly domed posterior section of pleomere 1; (2) the square merus of maxilliped 3; (3) the short eyestalk with transverse distal margin; and (4) the relatively shorter telson. The square merus of maxilliped 3 resembles that figured for *C. sibogae* and the eyestalk could be interpreted as belonging to this species, but the rostrum is scarcely carinate, specifically mentioned by De Man (1905, 1925a), and the telson is relatively shorter than in his figure. *Coriollianassa maputo* is weakly separated from two other species in the molecular phylogeny of Robles et al. (2020).

*Coriollianassa nyinggulu* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:E210BEFB-935A-48F6-99C8-79CE3F6BEAF1>

Figures 19, 20

*Callianassa* sp. MoV 4962.—Poore et al., 2008: 94 (North West Shelf, Australia).

**Material examined.** Holotype. **Australia**. WA, North West Shelf, off Ningaloo South, 22.079° S, 113.796° E, 201–206 m (CSIRO stn SS10/2005/146), NMV J53455 (male, 7.6 mm). Other material. **Australia**, NT, Arafura Sea, 9° 18.21' S, 133° 41.82' E, 187 m, gravel (CSIRO stn SS05/2005/029/GR052), AM P.74540 (male, 3.9 mm).



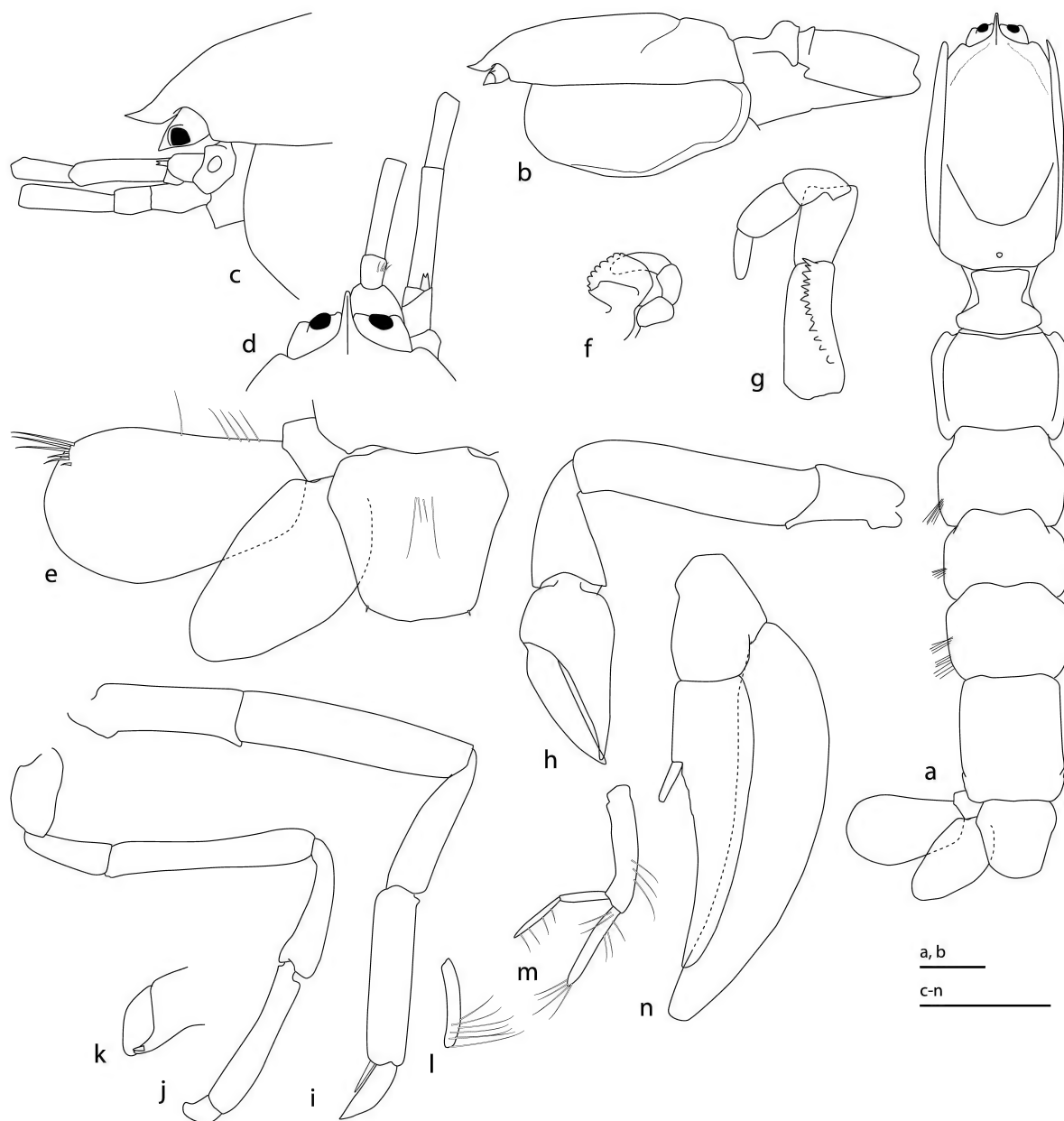


Figure 18. *Coriollanassa maputo* sp. nov. Mozambique, MNHN IU-2014-10472, female, 3.9 mm: a, eyestalks, carapace, pleon, telson, left uropod; b, carapace, eyestalk, pleomeres 1, 2; c, d, anterior carapace, eyestalk, antennular, antennal peduncles (lateral, dorsal views); e, telson, left uropod; f, mandible; g, maxilliped 3; h, pereopod 2; i, pereopod 4; j, k, pereopod 5 with detail; l–n, pleopods 1–3. Scale bars = 1 mm.

**Diagnosis.** Rostrum acute, with weak dorsal carina, with ventral straight keel-like carina. Antennular peduncle reaching to midpoint of antennal peduncle article 4. Maxilliped 3 merus with rounded oblique mesiodistal margin. Telson trapezoidal, 1.1 times as long as wide.

**Description of male holotype.** Rostrum laterally compressed, situated well below upper level of carapace, dorsally moderately carinate, with ventral straight keel-like carina, acute in dorsal and lateral views. Carapace almost straight, depressed anteriorly, in lateral view, as long as pleomeres 1–3 combined; orbital

margin concave; anterolateral angle produced anteroventrally as narrow lobe; subanterolateral margin convex, anterior margin of branchiostegite set well back, almost vertical; cervical groove across 0.75 length of carapace, almost reaching linea thalassinica. Pleomere 1 tergite waisted in dorsal view, with shallow saddle visible in lateral view; posterior section flat in lateral view. Pleomere 2 widest, wider than long, laterally flared. Pleomeres 3–5 each wider than long; pleura each with patch of plumose setae. Pleomere 6 0.8 times as long as wide, as long as pleomere 5, with slight ventrolateral projection.

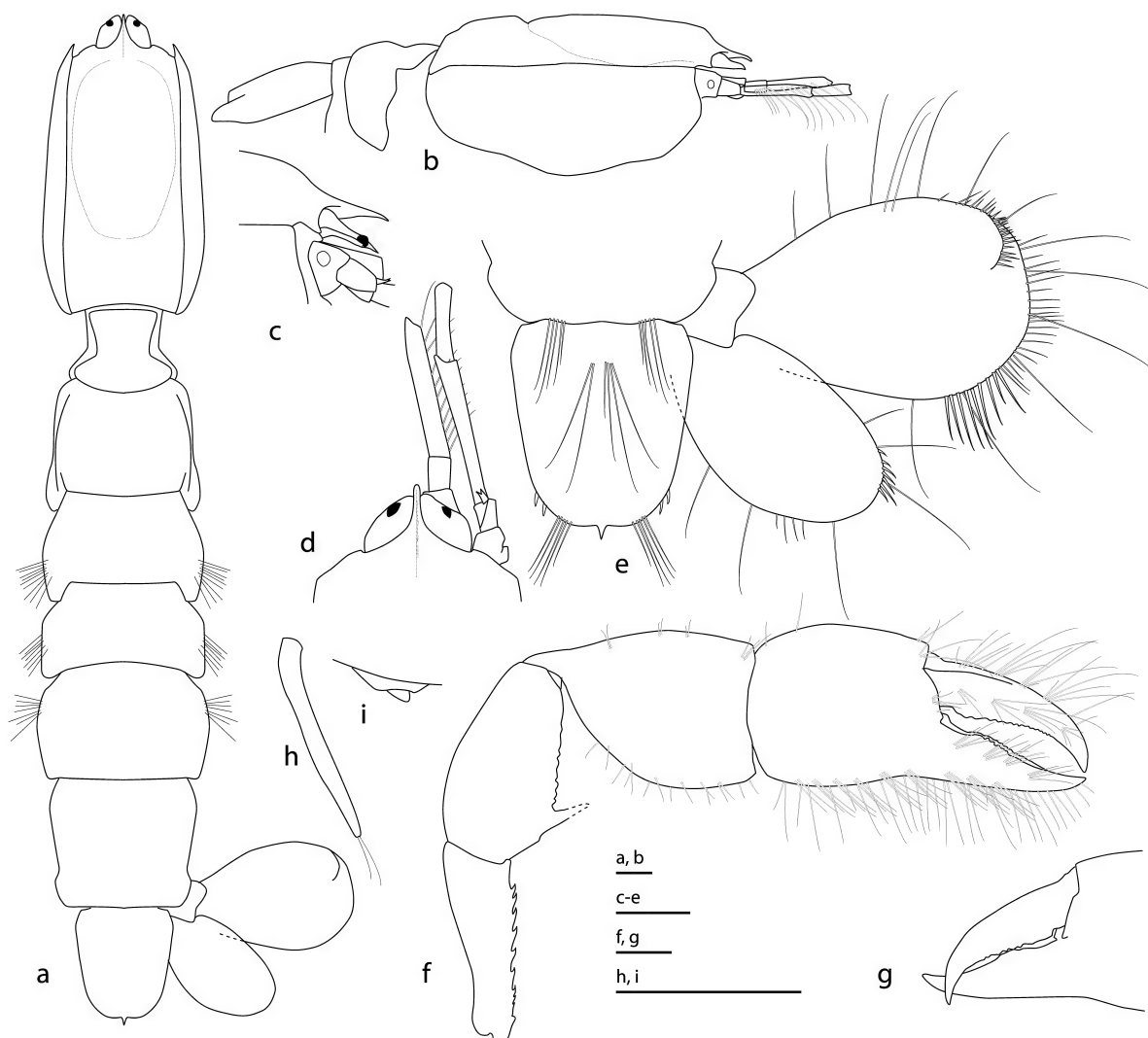


Figure 19. *Coriollanassa nyinggulu* sp. nov. NW Australia, NMV J53455, male, 7.6 mm. a, eyestalks, carapace, pleon, telson, right uropod; b, carapace, eyestalk, antennular, antennal peduncles, pleomeres 1, 2; c, anterior carapace, eyestalk, base of antennule (lateral); d, anterior carapace, eyestalk, antennular, antennal peduncles (dorsal view); e, telson, right uropod; f, major cheliped (left, mesial); g, cheliped fingers (lateral); h, i, right pleopods 1, 2 (in situ). Scale bars = 1 mm.

Eyestalk as long as wide, with oblique dorsal face diverging from rostrum, with sharp slightly upturned ventrolateral margin, anterolateral margin oblique, anteromedial angle thin, rounded in dorsal view, overreaching distal margin of antennular peduncle article 1. Cornea subdistal, domed.

Antennular peduncle reaching to midpoint of antennal peduncle article 4; article 1 clearly visible in dorsal view; article 2 shorter than article 1; article 3 1.6 times as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of sparse long setae. Antennal peduncle article 5 0.5 length of article 4; scaphocerite with bifid apex.

Maxilliped 3 ischium tapering, 1.5 times as long as wide at base, crista dentata comprising row of about 18 strong, irregular, erect spines, stronger distally, overlapping distal margin; merus about 0.7 times as long as ischium measured along outer margin, about 1.35 times as wide as long, wider than distal margin of ischium, with distinct oblique mesiodistal margin; carpus shorter than merus; propodus ovoid, 1.8 times as long as wide; dactylus digitiform, 0.7 times as long as propodus.

Male major cheliped massive, carpus-palm upper margin 0.95 carapace length. Ischium expanding distally, upper margin sinuous, unarmed; lower margin with row of 10 spines (proximal 3 minute). Merus as long as ischium, 1.8 times as long as wide (tooth excluded), tapering distally; upper margin convex, unarmed; lower margin with oblique spine bearing a subproximal tubercle, plus row of small tubercles distal to spine. Carpus 1.5 times as long as wide, with constricted "neck"; margins carinate; upper margin smooth, concave over proximal third; lower margin convex, distally rounded. Propodus upper margin 0.75 times as long as carpus; palm barrel-shaped, 1.1 times as long as wide; upper margin

carinate; lateral surface smooth, convex, with tubercle in gape; mesial surface slightly convex, with slight angle in gape set back from lateral peg; lower margin carinate, with row of setae extending onto fixed finger; fixed finger 0.9 times as long as palm, barely depressed; cutting edge denticulate. Dactylus reaching as far as fixed finger, curved distally, with acute tip; upper margin with tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge with few rounded teeth diminishing distally; mesial surface with tufts of setae along cutting edge.

Minor cheliped missing.

Pereopod 2 merus lower margin slightly sinusoidal, 3.2 times as long as wide; carpus about twice as long as wide; chela subtriangular; palm about twice as wide as upper margin; dactylus 3 times as long as palm upper margin. Pereopod 3 carpus subtriangular, 2.6 times as long as wide; propodus suboval with produced lower proximal margin, upper margin 1.3 times width, lower margin convex, faintly undulate, marginal setae clustered on prominences, with 1 slender spiniform seta subdistally; dactylus about 0.8 times as long as propodus upper margin. Pereopod 4 carpus 0.7 length of merus; propodus 0.8 times as long as carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with spiniform seta parallel to dactylus; dactylus half as long as propodus. Pereopod 5 slender, with chela about as long as carpus, slightly curving; dactylus as long as fixed finger.

Male pleopod 1 uniaarticulate, 8 times as long as wide, with few distal short setae. Pleopod 2 tubercle-like. Pleopods 3–5 biramous, rami narrow; appendix interna slender, rod-like, projecting well beyond mesial margin of endopod, bearing coupling hooks on apical margin.

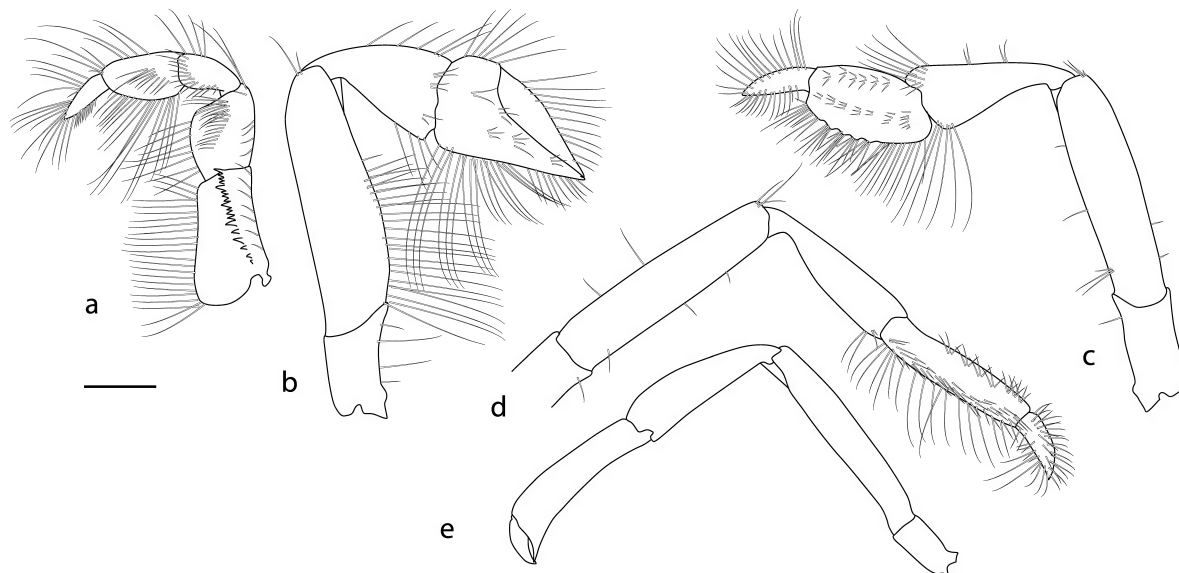


Figure 20. *Coriollanassa nyinggulu* sp. nov. NW Australia, NMV J53455, male, 7.6 mm. a, maxilliped 3; b–e, pereopods 2–5. Scale bar = 1 mm.

Uropodal endopod and exopod overreaching posterior margin of telson. Endopod oval, about 1.7 times as long as wide; anterior margin slightly convex; anterodistal margin with 8 spiniform setae; distal margin convex, with fringe of setae; posterior margin with 4 stouter marginal setae; upper surface without spiniform setae. Exopod dilating to rounded distal margin, 1.5 times as long as wide, exceeding endopod by about one third length; anterior margin convex, setose; posterior margin with numerous slender setae, with about 8 blade-like setae, indistinguishably merged with distal margin; upper surface with 2 submarginal slender setae near midpoint; dorsal plate curved, short, about one third exopod width, with row of about 12 stiff setae distinct from setal row of distal margin.

Telson elongate-trapezoidal, 1.1 times as long as wide, broadest at anterior fifth, narrowing posteriorly; greatest width 1.4 times posterior width; dorsal surface with few medial setae anterior to midlength; lateral margin with 2 spiniform setae near posterolateral angle; posterior margin convex, with median tooth.

**Etymology.** *Nyinggulu* is the name given to the Ningaloo reef and coast by the local Indigenous people (noun in apposition).

**Distribution.** Northwest Australian Shelf, Sahul Shelf; 187–206 m.

**Remarks.** *C. nyinggulu* is notable for the broad oval uropodal exopod, the stiletto-shaped rostrum, and the length of the antennular peduncle relative to the antennal peduncle (it reaches the midpoint of article 5, whereas it reaches only the distal margin of article 4 in all other species).

### *Coriollanassa sibogae* (De Man, 1905)

#### Figure 21

*Callianassa sibogae* De Man, 1905: 613–614.—Ngoc-Ho, 1994: 54–56, fig. 3 (North West Shelf, Australia).

*Callianassa (Cheramus) sibogae*.—De Man, 1928a: 124–127, pl. 11 fig. 17.

*Cheramus sibogae*.—Ngoc-Ho, 2005: 77, fig. 15 (French Polynesia).

*Trypaea sibogae*.—Sakai, 2011: 408–409.

*Coriollanassa sibogae*.—Poore et al., 2019: 93, 140, 142.

**Material examined.** **Australia.** WA, North West Shelf, between Port Hedland and Dampier, 18° 41' S, 118° 39' E, 134 m (MV stn NWA21), NMV J22662 (1 male, 3.8 mm; female, 5.4 mm); 18° 45' S, 118° 24' E, 142 m (MV stn NWA23), MNHN Th1248 (female, 4.0 mm) (det. Ngoc-Ho, 1994). **French Polynesia.** Raiatea Is., 16° 43.17' S, 151° 25.67' E, 309 m, MNHN Th1434 (female, 7.5 mm).

**Diagnosis.** Rostrum sharply carinate dorsally, concave on each side, bulbous ventrally. Maxilliped 3 merus distally truncate, with obtuse mesiodistal angle. Telson trapezoidal, 1.1 times as long as wide.

**Distribution.** Western Coral Triangle (type locality: Bali Sea, 7° 46' S, 114° 30.5' E, 330 m – *Siboga* stn 5), Northwest Australian shelf; 134–330 m.

**Remarks.** De Man (1905) based *Callianassa sibogae* on a single specimen of cl. 6.8 mm without chelipeds and pereopods 3 and 4 from 330 m in the Bali Sea. He described the rostrum as “lamellar, strongly compressed, with sharp upper edge, acuminate”, tergum of pleomere 1 as “saddle-shaped, carrying

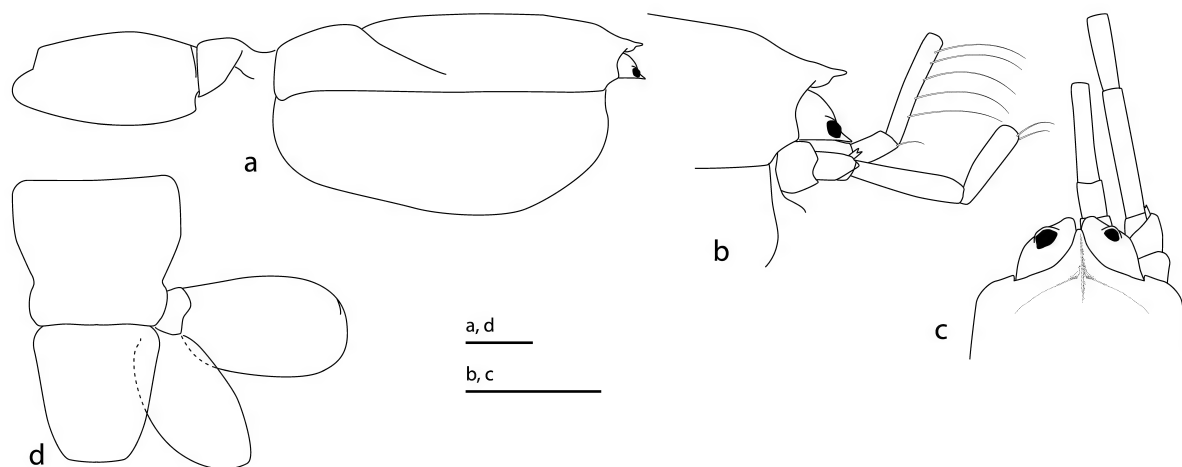


Figure 21. *Coriollanassa sibogae* (De Man, 1905). Australia, North West Shelf, NMV J22662 (female, 5.4 mm). a, carapace, pleomeres 1, 2; b, c, anterior carapace, eyestalk, antennular, antennal peduncles (dorsal, lateral views); d, pleomere 6, right uropod. Scale bars = 1 mm.

on the middle of its wider posterior part a compressed, low tubercle, appearing here thus carinate” and the merus of maxilliped 3 as “quadrangular, shorter than the ischium, somewhat widening anteriorly”. The two specimens from the North West Shelf of Australia determined by Ngoc-Ho (1994) are consistent with this description and De Man’s (1928a) figures. *Coriollanassa sibogae* is notable for the anteriorly directed rostrum being sharply carinate above and bulbous below and the almost right-angled distomesial margin of maxilliped 3.

The specimen from French Polynesia attributed to this species by Ngoc-Ho (2005) most probably belongs to this species, although critical elements (maxilliped 3, major cheliped) are missing.

### *Darryllanassa* gen. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:242F9105-478D-4639-BA51-F612343036D1>

**Diagnosis.** Rostrum acute. Pleomere 1 tergite undivided or with weak transverse step. Cornea well-defined, pigmented, eyestalk distal lobes blunt, oriented vertically. Antennular peduncle length about twice width of both eyestalks, little shorter than antennal peduncle; articles 2 and 3 with single lateral row of few well-spaced long setae. Antennal scaphocerite simple, longer than wide, acute. Maxilliped 3 merus as long as wide at ischium-merus suture; crista dentata with proximal row of 5 spines and distal dentate blade; dactylus tapering, with scattered setae over upper margin, dense brush of short setae distally on lower margin. Female major cheliped merus with oblique spine halfway along lower margin; propodus distal margin and fixed finger having lateral and medial cutting edges separated by shallow groove and deep cavity at base (under dactylus). Minor and major chelipeds of female similar; minor cheliped merus lower margin with spine at or near midpoint; carpus upper margin longer than propodus. Pereopod 3 propodus elongate-oval, tapering, without proximal lobe on lower margin. Pleopods 3–5 appendices internae longer than broad, clearly emerging from margin of endopod. Uropodal endopod ovoid, longer than wide, anterior margin straight, posterodistal margin evenly convex, without facial setae. Uropodal exopod about 1.5 times as long as wide, distal margin poorly differentiated from anterior margin, anterodistal corner rounded, with wide elevated dorsal plate. Telson about as wide as long, tapering from anterolateral lobe; anterolateral lobe prominent, defined posteriorly by clear unchitinised region; transverse ridge with only fine setae.

**Type species.** *Darryllanassa felderi* sp. nov. (by present designation).

**Etymology.** For Darryl L. Felder, University of Louisiana at Lafayette, Lafayette, Louisiana, honouring his considerable contribution to callianassid taxonomy and ecology, by combining his given names with *Callianassa*.

**Remarks.** *Darryllanassa* is erected for a single species unique in the possession of two similar chelipeds, each with fingers longer than the palm and with a deep groove and basal cavity

on the fixed finger. The cheliped merus lacks a proximal tooth. Pereopod 3 has an oval propodus without a strong “heel”, similar to that in *Cheramus* and *Scallasis*, but not as simple as in *Lipkecallianassa* Sakai, 2002. Maxilliped 3 is relatively narrow (pediform) compared to many callianassid genera, in which it is operculiform. The male is unknown. DNA could not be retrieved from tissue samples so its molecular affinities could not be determined.

### *Darryllanassa felderi* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:FC91087C-2DC4-4E01-B5A1-919D4CDF750C>

Figures 22, 23

**Material examined.** Holotype. **Papua New Guinea.** Madang Province, Alexishafen, 05° 05.3' S, 145° 48.0' E, 8–13 m (PAPUA NIUGINI stn PS14), MNHN IU-2017-1354 (female, 4.3 mm).

**Description of female holotype.** Rostrum triangular, situated at level of dorsal carapace, 0.65 length of eyestalk. Carapace well calcified, dorsally almost flat in lateral view, 1.3 times as long as pleomeres 1–2 combined; orbital margin oblique, convex; anterolateral lobe triangular; subanterolateral margin convex, oblique; anterior margin of branchiostegite with dorsal concavity, produced as narrow rounded lobe; cervical groove deeply incised, across 0.8 length of carapace, not reaching linea thalassinica. Pleomere 1 tergite without transverse groove, much narrower anteriorly. Pleomere 2 1.25 times as long as pleomere 1. Pleomere 5 slightly longer than pleomeres 3 and 4. Pleomere 6 about as long as pleomere 5, about as long as wide anteriorly.

Eyestalk slightly longer than wide, with dorsal face scarcely depressed anteriorly, proximally swollen, with sharp convex anterolateral margin, anteromedial angle sharply rounded in dorsal view, not overreaching distal margin of antennular peduncle article 1. Cornea densely pigmented, occupying small mid-distal area of eyestalk.

Antennular peduncle little shorter than antennal peduncle; article 1 visible in dorsal view only laterally; article 3 about as long as articles 1 and 2 combined; article 2 with few long setae; article 3 with few well-spaced ventrolateral setae. Antennal peduncle article 5 0.55 times as long as article 4; scaphocerite acute.

Mandible well calcified; molar process with double-toothed margin; incisor with triangular teeth. Other mouthparts typical of family (fig. 23h–n). Maxilliped 3 ischium not narrower distally, 1.8 times as long as wide, crista dentata comprising 5 strong independent curved teeth over proximal half, 8 smaller closer teeth forming blade over distal half; merus 0.5 times as long as ischium measured along outer margin, slightly wider than long, wider than ischium, with mesiodistal margin almost transverse, separated from rounded inner margin by obtuse rounded corner; carpus as long as merus outer margin; propodus ovoid-tapering, 1.7 times as long as wide; dactylus tapering, shorter than propodus, with scattered setae along upper margin, dense row of short setae along distal lower margin.

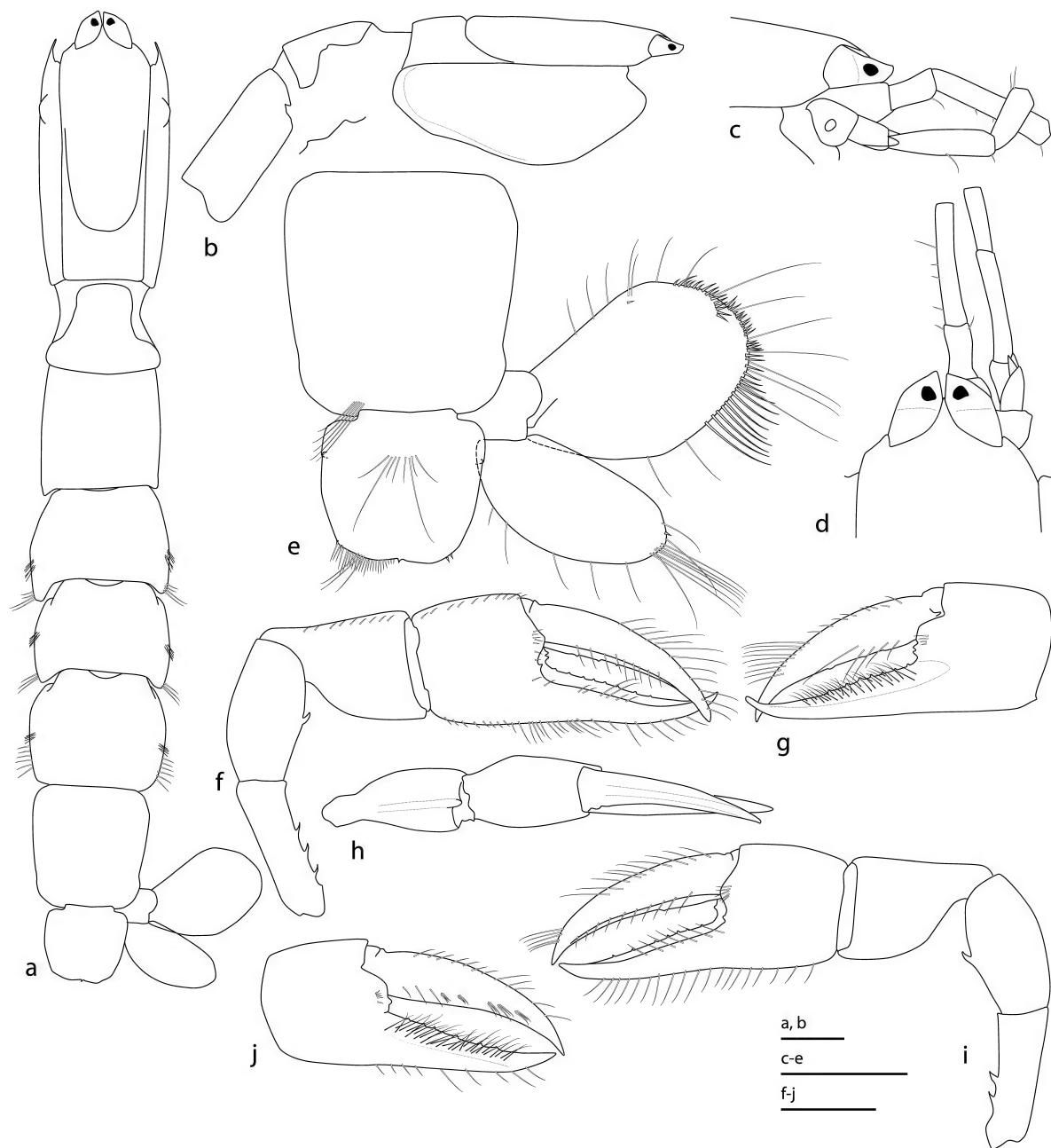


Figure 22. *Darryllianassa felderi* sp. nov. Papua New Guinea. MNHN IU-2017-1345, holotype female, 4.3 mm. a, eyestalks, carapace, pleon, telson, uropod; b, eyestalk, carapace, pleomeres 1, 2; c, d, anterior carapace, eyestalk, antennular, antennal peduncles (lateral, dorsal); e, pleomere 6, telson, right uropod; f, major cheliped (left, mesial); g, major cheliped propodus, dactylus (lateral); h, major cheliped carpus–dactylus (upper view); i, minor cheliped (left, mesial); j, minor cheliped propodus, dactylus (lateral). Scale bars = 1 mm.

Pereopods 1 (chelipeds) subequal in size, similar. Major cheliped carpus-palm upper margin 0.65 carapace length. Ischium scarcely expanding distally, upper margin straight, unarmed; lower margin with row of 3 similar spines. Merus 0.9 length of ischium, 1.9 times as long as wide (tooth excluded), ovate; upper margin convex, unarmed; lower margin with oblique spine near midpoint. Carpus 1.45 times as long as wide; upper margin with soft rounded ridge; lower margin carinate. Propodus upper margin 0.75 length of carpus; palm length 0.8 width; upper margin convex in lateral view, rounded; lateral surface smooth, convex, with slight ridge running along fixed finger, setose above this ridge; distolateral margin of palm produce, with 2 blunt teeth in gape; mesial surface convex, distomesial margin concave, set back from distolateral margin, with small tooth; lower margin carinate, with row of setae extending onto fixed finger; fixed finger 1.5 times as long as palm, tapering, with upturned tip; major cutting edge lateral, straight with regular row of 8 small triangular teeth, with more medial smooth ridge separated from major ridge by shallow groove and deep cavity at base (under dactylus). Dactylus as long as fixed finger, curved, with acute tip; upper margin ridged, with tufts of long setae; cutting edge doubly carinate, lateral carina with 3 small triangular teeth.

Minor cheliped essentially similar to major cheliped, 0.95 length. Ischium lower margin with 2 spines. Palm distolateral margin with 1 triangular tooth.

Pereopod 2 merus lower margin slightly sinusoidal, 3.0 times as long as wide; carpus about 1.6 times as long as wide; chela subtriangular; palm about 1.8 times as wide as upper margin; dactylus 2.7 times as long as palm upper margin. Pereopod 3 carpus 2.7 times as long as wide; propodus oval, 1.6 times as long as wide; lower margin without proximal heel, with long subdistal spiniform seta. Pereopod 4 coxa flattened ventrally, distal articles linear. Pereopod 5 chelate.

Pleopod 1 uniramous. Pleopod 2 biramous, exopod shorter than endopod. Pleopod 3 appendix interna emerging from endopod margin.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod elongate-oval, widest near midpoint, twice as long as wide; upper surface without spiniform setae; anterior margin almost straight; distal margin evenly convex, with 1 short spiniform seta plus cluster of submarginal fine setae; posterior margin setose. Exopod subrectangular, 1.6 times as long as wide, exceeding endopod by one third its length; anterior margin straight; all margins with numerous slender setae, with about 12 blade-like setae

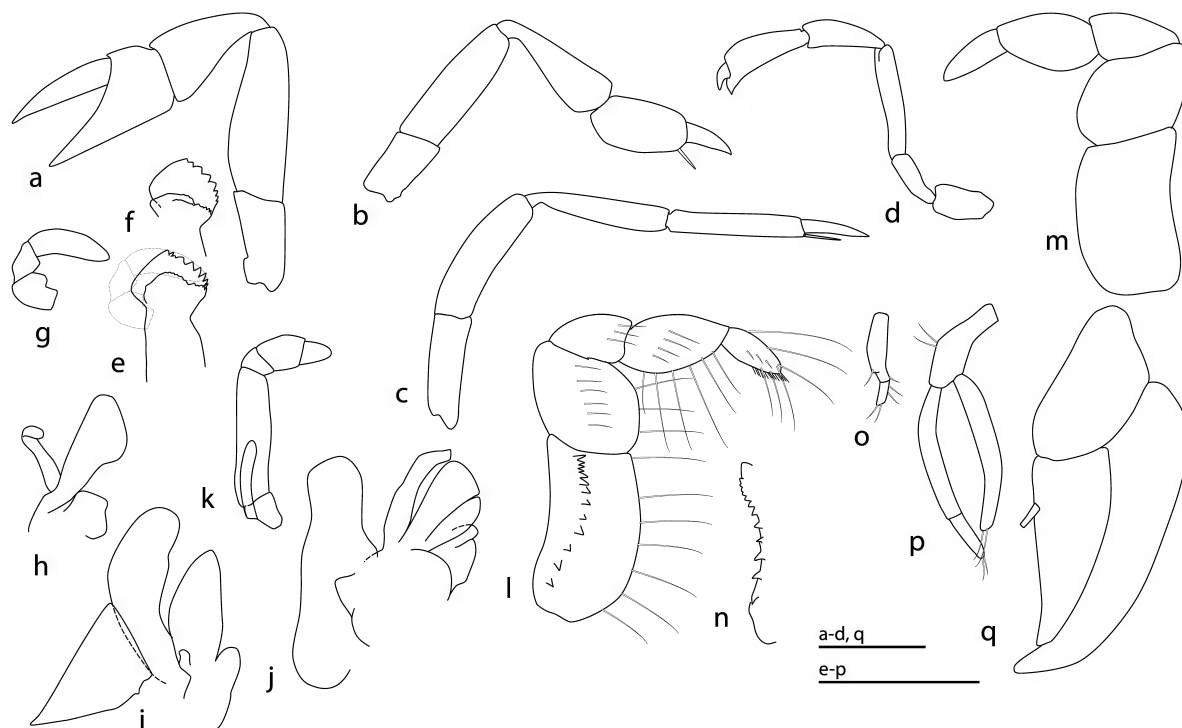


Figure 23. *Darryllianassa felderi* sp. nov. Papua New Guinea. MNHN IU-2017-1345, holotype female, 4.3 mm. a–d, pereopods 2–5; e, mandible (posterior view); f, mandible molar, incisor processes; g, mandibular palp; h, maxillule; i, maxilla; j, maxilliped 1; k, maxilliped 2; l, maxilliped 3 (inner view); m, maxilliped 3 (outer view); n, maxilliped 3 crista dentata (mesial view); o–q, pleopods 1–3. Scale bars = 1 mm.

on posterior margin indistinguishably merged with distal margin; dorsal plate reaching about halfway across exopod, of about 15 stiff setae; dorsal surface with 2 long setae and 1 small spiniform seta near distal anterior margin.

Telson 0.9 times as wide as long, broadest anteriorly, narrowing posteriorly to broadly rounded posterolateral corners; anterolateral lobes ventral to (overlapping) posterolateral margin; posterolateral corners each with 2 spiniform setae; posterior margin excavate, with minute median tooth; dorsal surface with few medial setae in row at 0.3 length.

**Etymology.** For Darryl L. Felder, University of Louisiana at Lafayette, Lafayette, Louisiana, honouring his considerable contribution to callianassid taxonomy and ecology, and his part in the study leading to this contribution.

**Distribution.** Eastern Coral Triangle (Papua New Guinea); 8–13 m (known only from type locality).

**Remarks.** The species is the only one in the genus and is immediately recognised by its equal chelipeds, each with fingers longer than the palm and with a deep groove and basal cavity on the cutting edge of the fixed finger.

### ***Necallianassa* Heard and Manning, 1998**

*Necallianassa* Heard and Manning, 1998: 883–884.—Poore et al., 2019: 95.—Robles et al., 2020.—Poore and Ahyong, 2023: 212.

*Trypaea*.—Sakai, 2011: 385–387 (partim; not *Trypaea* Dana, 1852).

**Remarks.** *Necallianassa* was erected for three species from the Atlantic and Mediterranean (Heard and Manning, 1998), all with a distal spine on the anterior margin of the uropodal endopod. *Necallianassa acanthura* (Caroli, 1946) and *N. berylae* Heard and Manning, 1998 possess a strong spine at the posterolateral margin of the telson and another at the base of the longitudinal ridge on the uropodal exopod. *Necallianassa truncata* (Giard and Bonnier, 1890) differs from these two in that the uropodal endopodal spine is the only one but it is much smaller than in the other two species (Ngoc-Ho, 2003). Here, a new species from Madagascar in the Indian Ocean is described.

### ***Necallianassa nosybeensis* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:6C594F1C-22DB-4ADD-8178-0EB02450F14B>

Figures 24, 25

*Necallianassa* MA-03.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** Holotype. **Madagascar.** Nosy Bé, E of Hellville, at CNRO complex, 13.4069° S, 48.2917° E, intertidal mud to silty sand flat with some rocks (stn MGNW-31), UF 14624 (female, 4.4 mm). Paratypes. Collected with holotype, UF 14499# (male, 3.0 mm); UF 14500 (male, 3.6 mm)

**Description. Female.** Rostrum triangular, blunt, flat, situated level with dorsal carapace, about one-third length of eyestalks. Carapace dorsally flat, as long as pleomeres 1–2 combined; orbital margin almost transverse; anterolateral lobes insignificant; subanterolateral margin oblique; anterior margin of branchiostegite with shallow dorsal concavity; cervical groove across 0.75 length of carapace, deep at midpoint,

reaching linea thalassinica. Thoracic sternite 7 subpentagonal; ventral surface with obsolete posterior median groove. Pleomere 1 tergite flat dorsally, wider posteriorly. Pleomere 2 about as wide across posterior margin as long. Pleomeres 3–5 each wider than long; pleura each with patch of plumose setae. Pleomere 6 about as long as wide, 1.2 times as long as pleomere 5.

Eyestalk about 1.2 times as long as wide, with dorsal face close to rostrum, anterolateral margin evenly tapering, convex, oblique, anteromedial angle rounded in dorsal view, reaching distal margin of antennular peduncle article 1. Cornea densely pigmented, sitting in distal part of eyestalk.

Antennular peduncle reaching distal margin of antennal peduncle; article 1 visible in dorsal view; article 3 about as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 0.85 length of article 4; scaphocerite semicircular.

Maxilliped 3 coxa with small mesial tooth; ischium dilating distally, 1.1 times as long as wide, crista dentata consisting of row of 11 small, well-spaced teeth; merus half as long as ischium measured along outer margin, about 1.6 times as wide as long, with mesiodistal margin evenly convex; carpus about as long as merus outer margin; propodus oval, 1.3 times as long as wide; dactylus 0.9 times as long as propodus, elongate-oval, with dense row of short setae along flexor (lower) margin.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped carpus-palm upper margin 0.9 carapace length. Ischium expanding distally, upper margin unarmed; lower margin unarmed. Merus shorter than ischium, 2.5 times as long as wide (tooth excluded), subrectangular; upper margin weakly convex; lower margin with small tooth at about third length. Carpus 1.2 times as long as wide; margins carinate. Propodus upper margin 0.8 carpus length; palm almost parallel-sided, as long as wide; upper and lower margins with slight ridge; lateral surface smooth, convex, with concave gape; mesial surface convex; lower margin with row of setae extending onto fixed finger; fixed finger 0.7 length of palm, triangular; cutting edge with row of 5 spaced triangular teeth. Dactylus as long as fixed finger, hooked distally; upper margin with tufts of long setae; cutting edge with 8 rounded teeth, more closely spaced over distal two thirds.

Minor cheliped carpus-palm upper margin as long as carapace length. Ischium lower margin unarmed. Merus 0.9 length of ischium; margins smooth. Carpus parallel-sided over most of length, 1.5 times as long as merus, 2.1 times as long as wide. Palm square, as long as wide; upper margin barely convex; lower margin carinate, with row of long setae extending on to fixed finger. Fixed finger triangular, almost as long as palm, cutting edge with 7 triangular teeth over proximal two thirds. Dactylus as long as palm, curved; cutting edge smooth.

Pereopod 2 merus lower margin slightly sinusoidal, 2.5 times as long as wide; carpus 1.6 times as long as wide; chela subtriangular; palm 1.6 times as wide as upper margin; dactylus twice as long as palm upper margin. Pereopod 3 carpus subtriangular, twice as long as wide; propodus wider than long, with evenly curved lower margin, marginal setae evenly spaced, without gaps, with 1 short spiniform seta; dactylus shorter than propodus upper margin. Pereopod 4



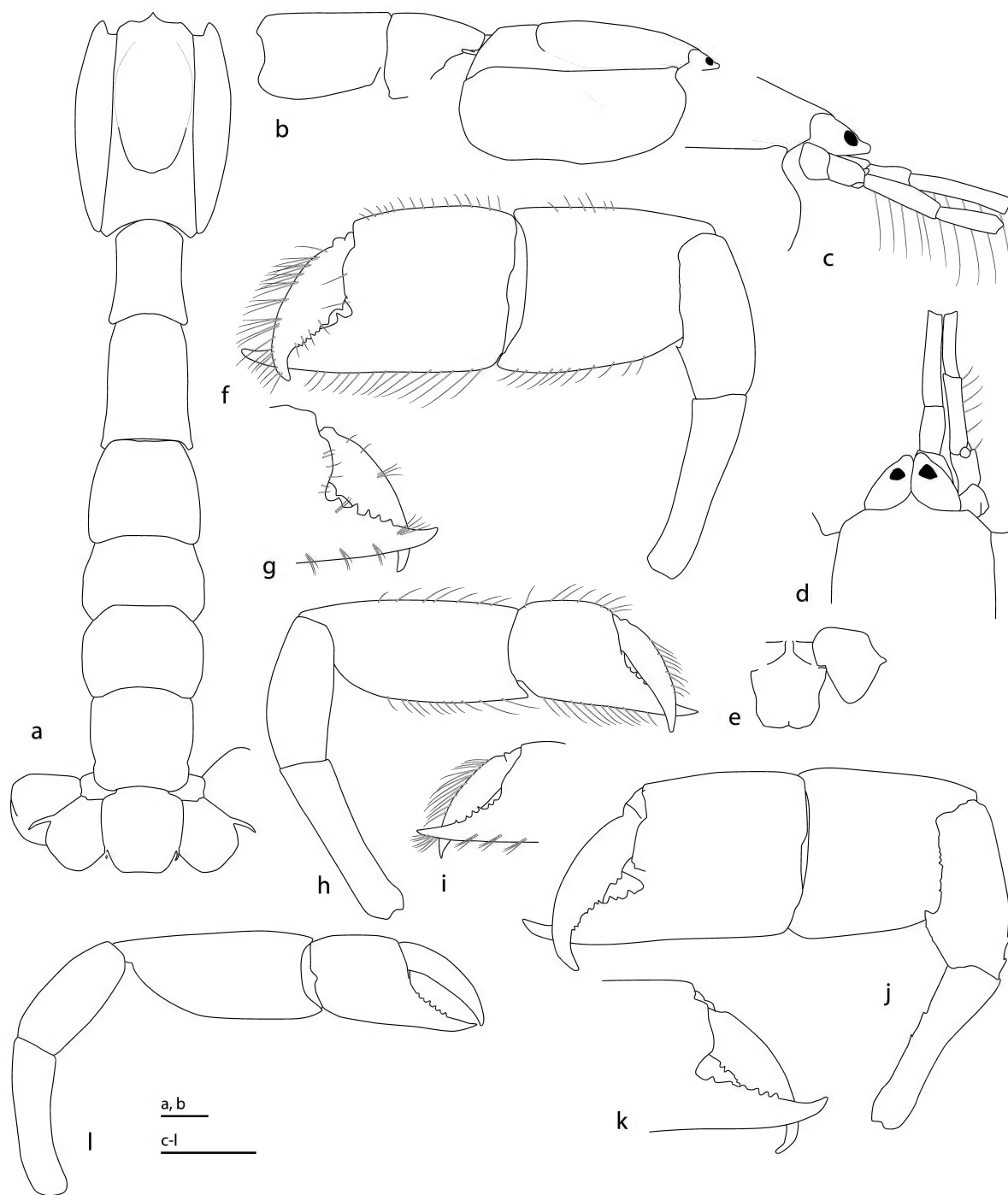


Figure 24. *Necallianassa nosybeensis* sp. nov. Madagascar. UF 14624, holotype female, 4.4 mm: a, carapace, pleon, telson, uropod endopods, dorsal; b, carapace, pleomeres 1, 2, lateral; c, d, anterior carapace, eyestalk, antennular, antennal peduncles; e, thoracic sternum 7, coxa 4; f, major cheliped (right, mesial view); g, major cheliped fingers (lateral view); h, minor cheliped (left, mesial view); i, minor cheliped fingers (lateral view). Paratype male, UF 14500: j, major cheliped (right, mesial view); k, major cheliped fingers (lateral view); l, minor cheliped (left, mesial view). Scale bars = 1 mm.

coxa flattened ventrally; carpus shorter than merus; propodus as long as carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with long spiniform setae parallel to dactylus; dactylus half as long as propodus. Pereopod 5 slender, chelate.

Pleopod 1 of 2 articles; ramus about as long as peduncle, with 3 distal setae. Pleopod 2 biramous; peduncle slightly bent; endopod 0.7 length of exopod; endopod of 2 articles, second short. Pleopods 3–5 biramous, endopod 1.7 times as long as wide; appendix interna twice as long as wide, projecting well beyond mesial margin of endopod, bearing coupling hooks on apical margin.

Uropod endopod and exopod scarcely overreaching posterior margin of telson. Endopod subcircular, about as long as wide; anterior margin straight, ending in sharp spine about 0.7 length of margin; posterodistal margins setose. Exopod widest at midpoint, about as long as wide; anterior margin straight; posterior margin with about 12 blade-like setae indistinguishably merged with densely setose distal margin; dorsal plate extending about 0.4 distance across exopod, scarcely differentiated from distal margin, comprising short stiff setae merging anteriorly with similar setae on distal margin; proximal plate with minute dorsal tooth.

Telson tapering, 1.3 times as long as wide, widest proximally, narrowing posteriorly to 1 minute and 1 posterolateral prominent curved spines; posterior margin concave, setose.

*Male.* Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped carpus-palm upper margin about as long as carapace length. Ischium expanding distally, upper margin unarmed; lower margin with 2 obsolete teeth. Merus about as long as ischium, 3 times as long as wide (tooth excluded), subrectangular; upper margin weakly convex, with 2 proximal teeth; lower margin with triangular tooth occupying proximal third, distally with irregular small teeth. Carpus as long as wide; margins carinate. Propodus upper margin 0.9 times as long as carpus; palm almost parallel-sided, as long as wide; upper and lower margins with slight ridge; lateral surface smooth, convex, with deep concave gape; mesial surface convex; fixed finger 0.7 length of palm, triangular; cutting edge with row of 6 irregular triangular teeth. Dactylus as long as fixed finger, hooked distally; cutting edge with irregular teeth, 2 forming a proximal molar.

Minor cheliped carpus-palm upper margin 0.8 carapace length. Ischium lower margin unarmed. Merus 0.8 length of

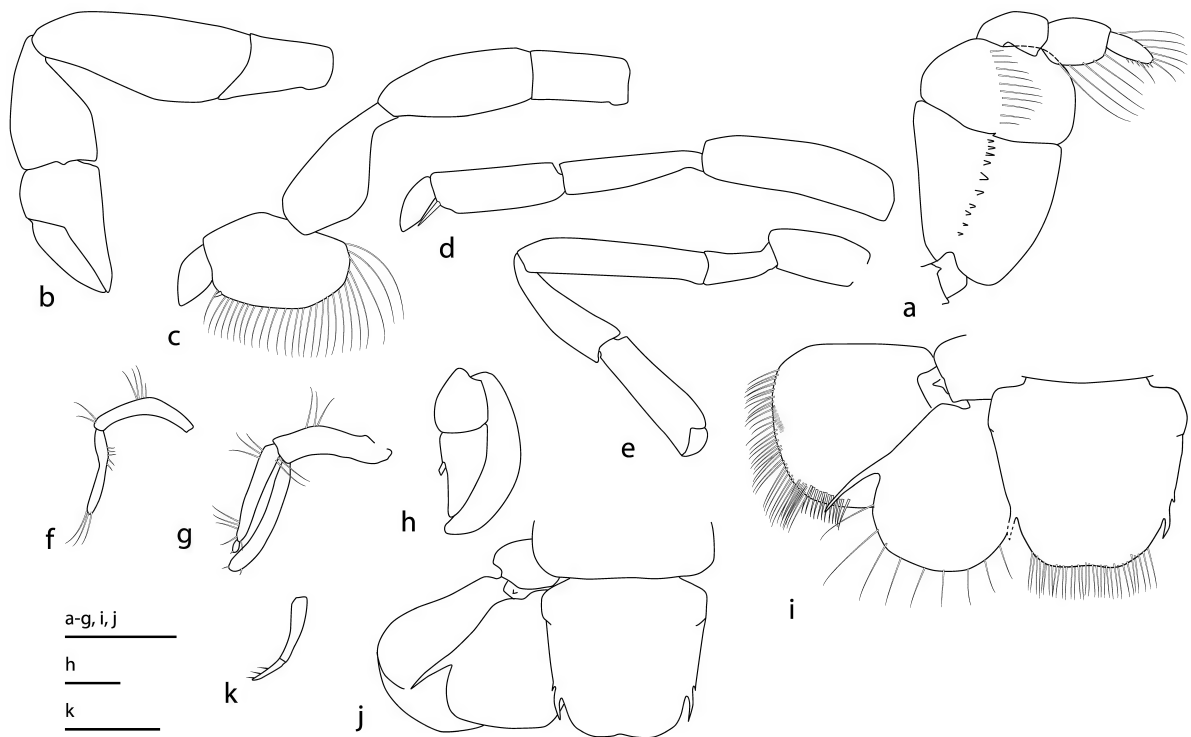


Figure 25. *Necallianassa nosybeensis* sp. nov. Madagascar. UF 14624, holotype female, 4.4 mm: a, maxilliped 3; b–e, pereopods 2–5; f–h, pleopods 1–3; i, telson, left uropod. UF 14500, paratype male; j, telson, left uropod. UF 14499, paratype male; k, pleopod 1. Scale bars = 1 mm.

ischium; margins smooth. Carpus parallel-sided over most of length, 1.5 times as long as merus, 2.3 times as long as wide. Palm square, as long as wide; upper margin barely convex; lower margin carinate. Fixed finger triangular, almost as long as palm, cutting edge with 6 triangular teeth over proximal half. Dactylus as long as palm, curved; cutting edge smooth.

Pleopod 1 small, curved, biarticulate. Pleopod 2 absent.

**Etymology.** From Nosy Bé, town in Madagascar, the type locality.

**Distribution.** Western Indian Ocean (Madagascar, known only from type locality); intertidal.

**Remarks.** The prominent spine at the base of the uropodal exopod found in *Necallianassa acanthura* (Caroli, 1946) and *N. berylae* Heard and Manning, 1998 (see Ngoc-Ho, 2003: fig. 8) is represented in *N. nosybeensis* by a minute tooth on the articulating proximal sclerite. The cheliped of the male of all previously described species possesses a strong meral hook and deep gape between the fingers; the cheliped of the two males in this collection have a relatively smaller tooth that is still more developed than the small spine of the female. The gape between the fingers is larger than in the female but not as much as in the other two species. *Necallianassa nosybeensis* differs from previously described species in having a row of triangular teeth along cutting edges of both fingers of the major cheliped and the fixed finger of the minor cheliped in both sexes. *Necallianassa nosybeensis* has a second minute posterolateral tooth on the telson; *N. acanthura* has one pair of spines, *N. berylae* has two similar spines, and *N. truncata* has none.

The new species was found close to *N. acanthura* and *N. truncata* in the molecular phylogram (Robles et al., 2020).

### ***Praedatrypaea* Poore, Dworschak, Robles, Mantelatto and Felder, 2019**

*Praedatrypaea* Poore et al., 2019: 97.—Robles et al., 2020: figs 1, 3, 6.—Poore and Ahyong, 2023: 213.

**Diagnosis.** Rostrum acute, anteriorly directed, usually shorter than eyestalks. Pleomere 1 tergite divided into 2 sections by transverse step. Pleomere 6 with sublateral ventral sharp ridge, flared posteriorly (where observed). Antennular peduncle exceeded by all or at least half of antennal peduncular article 5; articles 2 and 3 with single lateral row of well-spaced long setae along lower margin. Antennal scaphocerite simple, longer than wide, acute. Maxilliped 3 merus wider at ischium-merus suture than long, with or without distal spine on distal free margin. Male major cheliped merus smooth or with tooth at midpoint or with row of teeth along lower margin. Pereopod 3 propodus oval, lower margin slightly convex, leading to narrow sharply rounded proximal lobe. Uropodal endopod ovoid, longer than wide, anterior margin straight, posterodistal margin evenly convex, usually with spiniform setae near anterior and distal margins. Uropodal exopod about 1.5–1.8 times as long as wide, distal margin clearly differentiated from anterior margin, anterodistal corner right-angled, posterodistal margin with row of 6–8 long blade-like setae proximal to long setae on distal

margin. Telson anterolateral lobe prominent, defined posteriorly by clear unchitinised region; posterior margin convex between posterolateral angles or with medial notch, with medial spine.

**Remarks.** Members of *Praedatrypaea* are recognised by the weak calcification between the anterolateral lobe and the remainder of the telson (fig. 27e, f), the prominent posterior median spine on the telson sitting in a shallow concavity (e.g. fig. 28d) or not (fig. 27d), and the lower margin of the merus of the chelipeds with one tooth at its midpoint (rarely more). Most species possess a tooth on the distal margin of the merus of maxilliped 3 (e.g. fig. 27h).

Robles et al. (2020) found three well-separated species (*P. praedatrix* [De Man, 1905], *P. propinqua* [De Man, 1905] and *P. MOZ-34*) to belong to a clade sister to all other callianassid genera. Poore et al. (2019) included the two described species plus *P. modesta* (De Man, 1905) and *P. longicauda* (Sakai, 1967), all originally described from Indonesia, in *Praedatrypaea*. *Praedatrypaea praedatrix* and *P. propinqua* have been recorded from localities other than from their type localities; both have been recorded from the North West Shelf of Australia and another new species described herein occurs there. A second species of *Praedatrypaea* from Mozambique represented by a single small individual without chelipeds is also described below. *Praedatrypaea modesta* is diagnosed below. In *P. longicauda* the distal tooth on maxilliped 3 is obsolete, but is otherwise too poorly known to be diagnosed or included in the key to species below.

All these species have a tooth on the merus of maxilliped 3. Three species lacking the maxillipedal 3 meral tooth included in *Pugnatorypaea* by Poore et al. (2019) are here transferred to *Praedatrypaea*: *P. orientalis* (Bate, 1888) **comb. nov.**, *P. intermedia* (De Man, 1905) **comb. nov.** and *P. lobetobensis* (De Man, 1905) **comb. nov.** All possess a weakly chitinised suture isolating the anterolateral lobe of the telson and a row of teeth along the lower margin of the major chelipeds, similar to other species. In addition, *P. ruiyui* (Liu, 2022) **comb. nov.**, described from the northern South China Sea, is transferred from *Pugnatorypaea*, in which it was originally included, for the same reasons. From its illustrations, the species is difficult to distinguish from *P. orientalis*.

These transfers bring to 13 the number of named species of *Praedatrypaea*. The genus varies in other ways besides the presence or absence of a meral tooth on maxilliped 3. The posterior margin of the telson ranges from convex to having a medial excavation, and the lower margin of the cheliped merus may have a single tooth at the midpoint or a row of teeth. This variability makes distinction from species of *Pugnatorypaea* difficult – *Pugnatorypaea* is restricted here to species with a basal spine on the merus of the major cheliped. In the light of this rearrangement, the diagnosis of the genus has been updated.

The telson and uropod of *Notiax bicauda* Sakai, 2010 from the Gulf of Tonkin, also included in *Pugnatorypaea* by Poore et al. (2019), are consistent with *Praedatrypaea* but its chelipeds are unknown. It remains a species inquirenda.

**Key to ten species of *Praedatrypaea*** (*P. bicauda*, *P. inhambane* and *P. longicauda* excluded)

1. Chelipeds with proximal tooth on upper margin of merus ..... 2
  - Chelipeds without proximal tooth on upper margin of merus ..... 3
2. Telson with convex lateral margins converging on pair of lobes (each as long as wide) separated by narrow median notch. Pereopod 3 propodus oval, 1.6 times as long as wide ..... *P. lobetobensis*
  - Telson with straight lateral margins converging on pair of lobes (each shorter than wide) separated by concave median notch. Pereopod 3 propodus elongate-oval, twice as long as wide ..... *P. intermedia*
3. Maxilliped 3 merus without tooth on distal margin ..... *P. orientalis/P. ruiyui*
  - Maxilliped 3 merus with tooth on distal margin ..... 4
4. Pereopod 3 propodus linear (4 times as long as wide). Major cheliped fingers with irregular teeth along cutting edges. Uropodal endopod with 3 long spiniform setae close to distoposterior margin ..... *P. modesta*
  - Pereopod 3 propodus oval (2–4 times as long as wide). Major cheliped fingers with 1 tooth or smooth on cutting edge. Uropodal endopod without 3 long spiniform setae close to distoposterior margin (setae arranged otherwise) ... 5
5. Antennular peduncle reaching to end of antennal peduncle article 5. Telson as long as wide; anterolateral lobes near midpoint ..... *P. mandu*
  - Antennular peduncle reaching to end of antennal peduncle article 4 or midway along article 5. Telson longer than wide; anterolateral lobes proximal to midpoint ..... 6
6. Major cheliped carpus twice as long as wide ..... *P. ningaloo*
  - Major cheliped carpus about as long as wide ..... 7
7. Uropodal exopod rectangular, 1.6–1.9 times as long as wide ..... *P. propinqua*
  - Uropodal exopod rectangular-oval, 1.4–1.5 times as long as wide ..... 8
8. Telson 1.3 times as long as wide, posterior margin medially concave ..... *P. praedatrix*
  - Telson 1.2 times as long as wide, posterior margin convex ..... *P. jangamo*

***Praedatrypaea inhambane* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:DFE9A6D4-4E55-4070-9A5C-8573163E2951>

Figure 26

**Material examined.** Holotype. **Mozambique**, Mozambique Channel, Inhambane transect, 24° 15.70' S, 35° 42.20' E, 605–612 m

(MAINBAZA stn CC3165), MNHN IU-2008-10312# (female, 4.3 mm, without pereopods).

**Diagnosis.** Antennular peduncle reaching just beyond distal margin of antennal peduncle article 4. Maxilliped 3 ischium about 1.6 times as long as wide; merus subsquare, about 1.2 times as wide distally as long, with small tooth on transverse distal margin. Chelipeds unknown. Uropod endopod oval, 1.5 times as long as wide; anterior margin slightly convex, with 5 distal stout setae; distal margin convex; dorsal face without proximal spiniform setae. Uropod exopod widest subdistally, 1.3 times as long as wide; anterior margin almost straight, with few setae. Telson 1.4 times as long as wide, widest at strong lateral lobes at one sixth length; posterior margin convex, with median spine.

**Description of female holotype.** Rostrum acute, narrow in dorsal view, situated below level of dorsal carapace, 0.75 length of eyestalks. Carapace orbital margin almost transverse; anterolateral lobes triangular; subanterolateral margin steeply oblique. Pleomere 6 damaged.

Eyestalk 1.55 times as long as wide, with oblique dorsal face diverging from rostrum, anterolateral margin convex, thin, flange-like, not reaching distal margin of antennular peduncle article 1. Cornea with small separate pigmented ommatidia, sitting in midpart of eyestalk.

Antennular peduncle reaching one third way along antennal peduncle article 5; article 1 visible in dorsal view; article 3 shorter than articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 0.6 length of article 4; scaphocerite triangular in dorsal view.

Maxilliped 3 ischium subrectangular, about 1.6 times as long as wide, crista dentata flange-like, of row of about 20 uneven contiguous teeth (ischium triangular in cross-section); merus subsquare, 0.7 length of ischium measured along outer margin, about 1.2 times as wide distally as long, with small tooth on transverse distal margin; carpus about as long as merus outer margin; propodus tapering, 1.9 times as long as greatest width; dactylus 0.8 length of propodus, elongate-oval, with dense row of short setae along flexor (lower) margin.

Chelipeds, pereopods unknown.

Uropod endopod and exopod not overreaching posterior margin of telson. Endopod oval, 1.5 times as long as wide; anterior margin slightly convex; anterodistal margin with 5 subdistal spiniform setae; dorsal face unarmed. Exopod widest subdistally, 1.3 times as long as wide; anterior margin almost straight, with few setae; posterior margin with about 10 falcate setae indistinguishably merged with densely setose distal margin; dorsal plate differentiated from distal margin, comprising 2 or 3 rows of short and medium stiff setae merging anteriorly with similar setae on distal margin; dorsal face without spiniform seta.

Telson 1.4 times as long as wide, widest at strong lateral lobes at one sixth length; narrowing posteriorly to rounded corner leading to posterior margin; posterolateral margin convex, setose, with medial spine.

**Etymology.** From Inhambane, Mozambique, city near the type locality (noun in apposition).

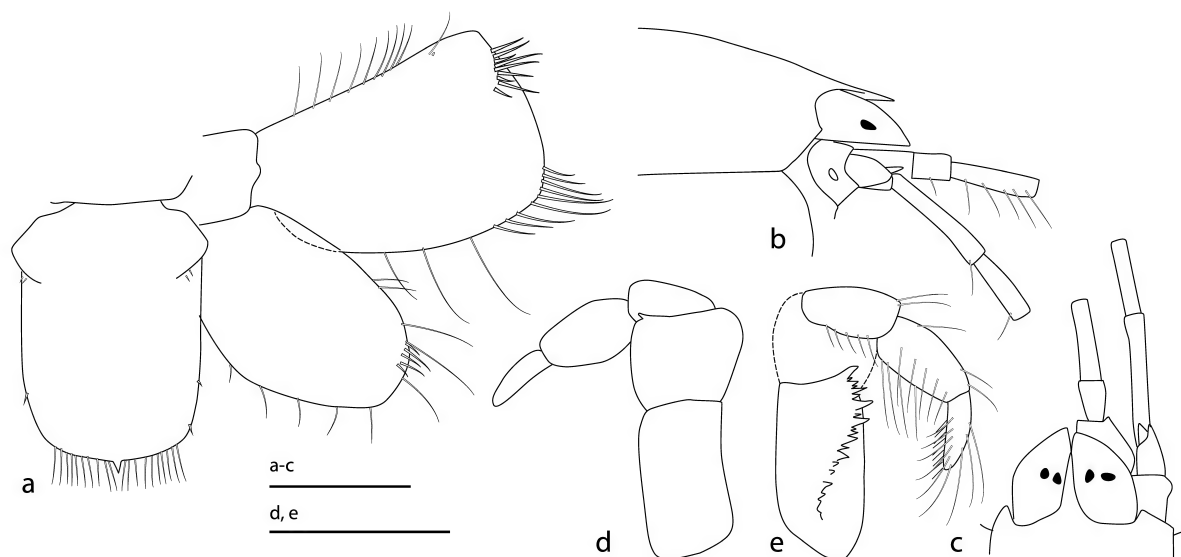


Figure 26. *Praedatrypaea inhambane*. Mozambique, MNHN IU-2008-10312, female, 4.3 mm: a, telson, right uropod; b, c, anterior carapace, antennular peduncles, eyestalks (lateral, dorsal views); d, maxilliped 3 (outer view, merus flattened); e, maxilliped 3 (inner view, merus flexed). Scale bars = 1 mm.

**Distribution.** Western Indian Ocean; 605–612 m (known only from type locality).

**Remarks.** A single incomplete specimen was referable to this genus on the basis of the maxilliped 3, telson, rostrum and antennae. It was taken close to the type locality of *P. jangamo* sp. nov. but at a greater depth. The specimen was much smaller than the type of *P. jangamo* and differed in the position of the tooth on the merus of maxilliped 3 and in shapes of the telson and uropod. The specimen differs from all other species in the mesial position of the tooth on the maxilliped 3 merus and the absence of facial setae on the uropodal rami.

***Praedatrypaea intermedia* (De Man, 1905) comb. nov.**

*Callianassa intermedia* De Man, 1905: 609–610.—Sakai, 1999: 46.—Tudge et al., 2000: 143.—Sakai, 2005: 86.

*Callianassa* (*Cheramus*) *intermedia*.—De Man, 1928b: 26, 98, 143–146, pl. 14 fig. 21.

*Trypaea intermedia*.—Sakai, 2011: 398–399.

*Pugnatrypaea intermedia*.—Poore et al., 2019: 138, 143.

**Diagnosis.** Antennular peduncle reaching distal margin of antennal peduncle article 4. Maxilliped 3 unknown. Chelipeds meri upper margins each with subproximal spine. Major cheliped merus lower margin with row of teeth; carpus about as long as wide; palm about twice as long as carpus, 1.3 times as long as wide; fingers with cutting edges with obsolete teeth in female, with irregular teeth in male. Uropod endopod 1.2 times as long as wide; anterior margin convex, with 2 distal stout setae; distal-posterior margin strongly convex distally; dorsal face with 3 distal long setae. Uropod exopod widest distally,

little longer than wide; anterior margin straight, not setose. Telson 1.15 times as long as wide, widest at strong lateral lobes at one-third length; posterior margin with obtuse medial depression, with medial spine; with 2 pairs of spiniform setae on posterolateral margins. Male pleopod 1 2-articled; pleopod 2 absent.

**Distribution.** Western Coral Triangle (known only from type locality: Indonesia, Bali Sea, 7° 46' S, 114° 30.5'E); 330 m.

**Remarks.** No material was examined – the species has not been recorded since its discovery. The diagnosis was prepared largely from the description and figures of De Man (1928a). Sakai (1999) observed that the holotype (not lectotype, as he stated) is a male, not a female. The presence of a tooth on maxilliped 3 merus is unknown.

***Praedatrypaea jangamo* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:801C7423-148A-4A4A-9249-0E3D2877BA9D>

Figure 27

*Praedatrypaea* MOZ-34.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** Holotype. **Mozambique**, off Praia de Jangamo, 24° 8.33' S, 35° 42.07' E, 406–410 m (MAINBAZA stn CC3163), MNHN IU-2008-10313\*# (male, 9.8 mm, without major cheliped).

**Diagnosis.** Antennular peduncle reaching distal margin of antennal peduncle article 4. Maxilliped 3 ischium about as long as wide; merus oval, about 1.35 times as wide as long, with tooth on convex distal margin. Chelipeds meri upper margins

each unarmed. Major cheliped unknown. Uropod endopod 1.5 times as long as wide; anterior margin straight, with about 10 distal stout setae; distal-posterior margin semicircular; dorsal face with 2–4 proximal spiniform setae, another 1–3 close to anterior margin and 1–3 distally. Uropod exopod widest distally, 1.4 times as long as wide; anterior margin convex, not setose. Telson 1.2 times as long as wide, widest at strong lateral lobes at one third length; posterior margin convex, with median

spine; with 1–3 pairs of spiniform setae on posterolateral margin; with 2 pairs of longitudinal rows of 2 spiniform setae. Male pleopod 1 2-articled; pleopod 2 biramous.

*Description. Male.* Rostrum acute, triangular in dorsal view, situated below level of dorsal carapace, half as long as eyestalks. Carapace dorsally convex, as long as pleomeres 1 and 2 combined; orbital margin almost transverse; anterolateral lobes

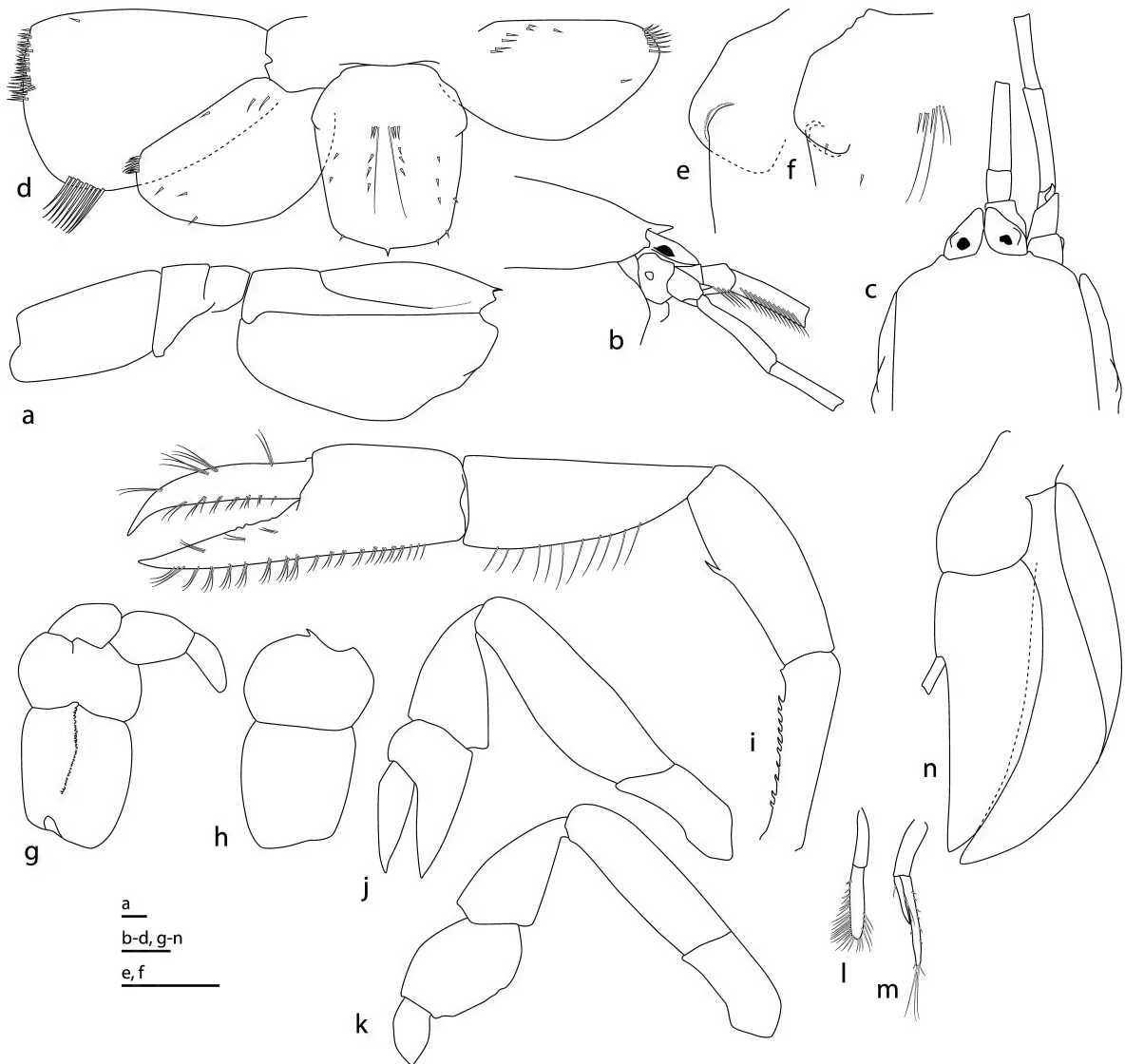


Figure 27. *Praedatrypaea jangamo* sp. nov. Mozambique, MNHN IU-2008-10313, holotype, male, 9.8 mm: a, carapace, pleomeres 1, 2 (lateral); b, c, anterior carapace, eyestalks, antennular, antennal peduncles (lateral, dorsal views); d, telson, left uropod, right uropodal endopod; e, telson, left anterolateral margin and lobe (oblique dorsoposterior view, posterior part of telson sitting in socket); f, telson, left anterolateral margin, lobe and setae on transverse ridge (dorsal view); g, maxilliped 3 (inner view); h, maxilliped 3 (inner view); i, maxilliped 3 ischium, merus (outer view); j, k, pereopods 2, 3; l–n, pleopods 1–3. Scale bars = 1 mm.

rounded; subanterolateral margin oblique; cervical groove across 0.75 length of carapace, shallow at midpoint, almost reaching linea thalassinica. Pleon damaged; pleomere 6 with oblique shelf protruding from posteroventral margin.

Eyestalk little longer than wide, with oblique dorsal face diverging from rostrum, anterolateral margin convex, oblique, anteromedial angle rounded in dorsal view, not reaching distal margin of antennular peduncle article 1. Cornea densely pigmented, sitting in proximal part of eyestalk.

Antennular peduncle reaching distal margin of antennal peduncle article 4; article 1 visible in dorsal view; article 3 about as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 0.75 length of article 4; scaphocerite comma-shaped in dorsal view.

Maxilliped 3 ischium subrectangular, about as long as wide, crista dentata consisting of row of about 30 uneven contiguous teeth; merus oval, 0.7 length of ischium measured along outer margin, about 1.35 times as wide as long, with mesiodistal margin evenly convex, with sharp mesially directed tooth; carpus about as long as merus outer margin; propodus tapering, 1.4 times as long as greatest width; dactylus 0.9 length of propodus, elongate-oval, with dense row of short setae along flexor (lower) margin.

Major cheliped unknown.

Minor cheliped carpus-palm upper margin 0.8 carapace length. Ischium lower margin with 10 similar teeth. Merus little longer than ischium; upper margin convex, smooth; lower margin with small tooth near midpoint. Carpus dilating, 1.15 times as long as merus, 2.8 times as long as wide. Palm 0.6 length of carpus, 1.3 times long as wide; upper margin barely convex; lower margin carinate, with row of setae extending onto fixed finger; fixed finger as long as palm, cutting edge obsoletely dentate. Dactylus longer than palm, curved distally; cutting edge smooth.

Pereopod 2 merus 3.2 times as long as wide; carpus 1.4 times as long as wide; chela subtriangular; palm 1.8 times as wide as upper margin; dactylus 2.4 times as long as palm upper margin. Pereopod 3 carpus subtriangular, twice as long as wide; propodus oval, longer than wide, with evenly curved lower margin, marginal setae in groups separated by gaps, with 1 short spiniform seta; dactylus 0.7 length of propodus upper margin. Pereopod 4 missing. Pereopod 5 chelate.

Pleopod 1 uniramous, article 2 longer. Pleopod 2 biramous, endopod half as long as exopod. Pleopods 3–5 biramous, endopod 2.6 times as long as wide; appendix interna narrow, 0.15 times as long as endopod.

Uropod endopod and exopod well overreaching posterior margin of telson. Endopod almost semicircular, 1.5 times as long as wide; anterior margin straight; anterodistal margin with about 10 subdistal spiniform setae; dorsal face with 2–4 proximal spiniform setae, another 1–3 close to anterior margin and 1–3 distally (slight differences between left and right endopods). Exopod widest distally, 1.4 times as long as wide; anterior margin convex, not setose; posterior margin with about 12 falcate setae indistinguishably merged with densely setose distal margin; dorsal plate moderately differentiated from distal margin, comprising 2 or 3 rows of

short and medium stiff setae merging anteriorly with similar setae on distal margin; dorsal face with short spiniform seta near anterior margin.

Telson 1.2 times as long as wide, widest at strong lateral lobes at one third length, narrowing posteriorly to rounded corner leading to posterior margin; posterolateral margin with 1–3 pairs of spiniform setae; posterior margin convex, setose, with medial spine; dorsal transverse ridge with 2 or 3 pairs of spiniform setae and long setae; dorsal surface with 2 pairs of longitudinal rows of 2 spiniform setae.

**Etymology.** From Praia de Jangamo, a local name in Mozambique near the type locality (noun in apposition).

**Distribution.** Western Indian Ocean (Mozambique Channel); 406–410 m.

**Remarks.** *Praedatrypaea jangamo* is known from a single male from deep water, two or three times as long as all other species. It is distinguished from other species by the broader uropodal rami and their pattern of spiniform setae. The rostrum is unusually short and the antennal article 5 longer than in other species.

#### *Praedatrypaea lobetobensis* (De Man, 1905) comb. nov.

Figures 1d, 28, 29

*Callianassa lobetobensis* De Man, 1905: 607.—Sakai, 1999: 48.—Tudge et al., 2000: 143.—Sakai, 2005: 91.

*Callianassa* (*Cheramus*) *lobetobensis*.—De Man, 1928b: 26, 93, 98, 137, pl. 13 fig. 20, pl. 14 fig. 20a–d.

*Cheramus lobetobensis*.—Sakai, 2011: 368.

*Pugnatorypaea lobetobensis*.—Poore et al., 2019: 138, 143.

**Material examined.** **Australia**, NT, Arafura Sea, 9° 12.331' S, 133° 38.903' E, 158 m, mud (CSIRO stn SS05/2005/032/BS006), AM P.74439 (ovigerous female, 5.3 mm, antennules missing; female, 3.2 mm). **WA**, North West Shelf, 16° 73.25' S, 119° 24.68' E, 695 m (CSIRO stn SS05/2007/73), NMV J60024 (juvenile, 1.6 mm); 16° 37.03' S, 120° 34.02' E, 410 m (CSIRO stn SS05/2007/12), NMV J6002 (juvenile, 1.5 mm); 9° 24.141' S, 134° 14.268' E, 97 m, muddy silt (CSIRO stn SS05/2005/014/GR023), AM P.74445 (damaged); 9° 7.587' S, 133° 25.289' E, 199 m (CSIRO stn SS05/2005/041/GR066), AM P.74470 (female, 3.0 mm). **Papua New Guinea**, Bismarck Sea, 03° 32' S, 148° 06' E, 540–586 m (MADEEP stn DW4248), MNHN IU-2015-109# (male, 3.3 mm).

**Diagnosis.** Antennular peduncle reaching distal margin of antennal peduncle article 4. Maxilliped 3 ischium about twice as long as wide; merus oval, about 1.5 times as wide as long, with tooth on oblique margin. Chelipeds meri upper margins each with subproximal spine. Major cheliped merus lower margin with spine at midpoint, or with 4 teeth over proximal half; carpus about as long as wide, or about twice as long as wide; palm about as long as or 1.5 times as long as carpus, 1.2 times as long as wide or about twice as long as wide; fingers, cutting edges with obsolete teeth. Uropod endopod 1.8 times as long as wide; anterior margin straight, with 2 small teeth, with 4 distal spiniform setae; distal-posterior margin strongly convex distally; dorsal face without facial setae. Uropod exopod rectangular, truncate distally, twice as long as wide; anterior margin straight, not setose. Telson 1.4 times as long as wide, widest at strong lateral lobes at one fifth length; posterior margin with 2

semicircular lobes separated by narrow notch filled by medial spine; with 2 pairs of spiniform setae on posterolateral margins. Male pleopod 1 2-articled; pleopod 2 biramous.

*Supplementary description. Female.* Rostrum laterally compressed, situated below upper level of carapace, with ventral convex keel-like carina, three quarters length of eyestalks. Carapace dorsally flat, as long as pleomeres 1–3 combined; orbital margin almost transverse; anterolateral

angle projecting, rounded; subanterolateral margin oblique; cervical groove across 0.7 length of carapace, reaching linea thalassinica. Pleomere 1 tergite waisted in dorsal view. Pleomere 6 about as long as wide, with ventrolateral projection.

Eyestalk 1.25 times as long as wide, with flat dorsal face, with sharp ventrolateral margin, anterolateral margin convex in dorsal view, not reaching distal margin of antennular peduncle article 1. Cornea terminal, occupying middle third of distal margin of eyestalk, darkly pigmented.

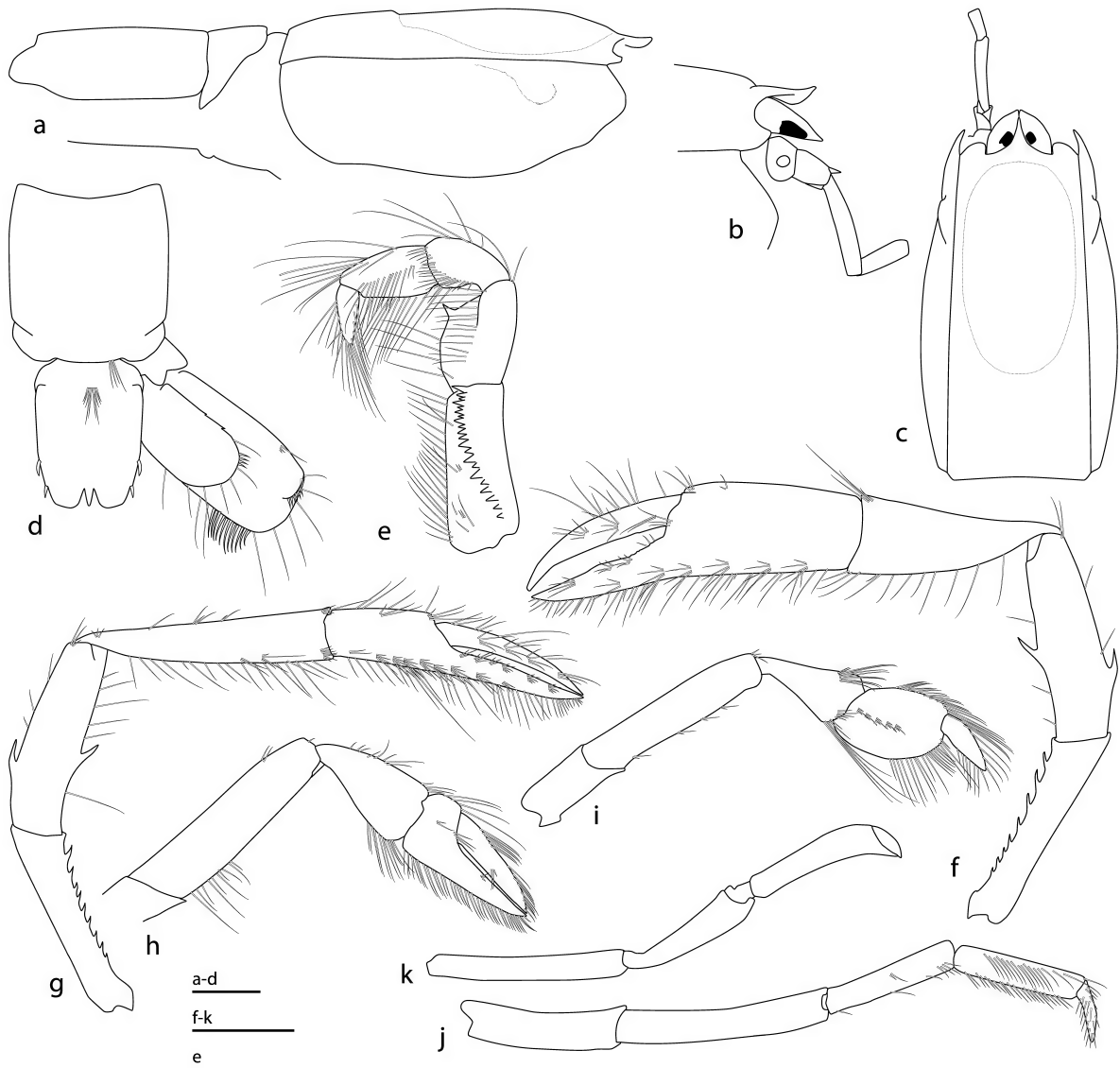


Figure 28. *Praedatrypaea lobetobensis* (De Man, 1905). Australia, Arafura Sea. AM P.74439, ovigerous female, 5.3 mm: a, carapace, pleomeres 1, 2; b, anterior carapace, eyestalk, antennal peduncle; c, carapace, eyestalks, left antennal peduncle; d, pleomere 6, telson, right uropod; e, maxilliped 3; f, major cheliped (right, mesial); g, minor cheliped (left, mesial); h–k, pereopods 2–5. Scale bars = 1 mm.



Antennular peduncle reaching distal margin of antennal peduncle article 4; article 1 clearly visible in dorsal and lateral views; article 2 shorter than article 1; article 3 as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of sparse long setae. Antennal peduncle article 5 0.6 length of article 4; scaphocerite minute, spiniform.

Maxilliped 3 ischium slightly tapering, 2.1 times as long as wide, crista dentata consisting of row of about 20 strong erect spines, stronger distally, overlapping distal margin; merus about 0.7 length of ischium measured along outer margin, about 1.45 times as long as wide, wider than ischium, with triangular tooth on mesiodistal margin; carpus slightly shorter than merus; propodus tapering, 1.9 times as long as wide; dactylus digitiform, 0.7 length of propodus, with long setae concentrated distally and along flexor margin.

Pereopods 1 (chelipeds) unequal, similar. Major cheliped linear, carpus-palm upper margin about as long as carapace length. Ischium slightly expanding distally, upper margin straight, unarmed; lower margin with row of 8 spines. Merus

about as long as ischium, 3 times as long as wide (spines excluded), slightly tapering distally; upper margin with 1 spine about one third way along; lower margin with oblique tooth near midpoint. Carpus 2.7 times as long as wide, elongate-triangular; upper margin smooth; lower margin convex. Propodus upper margin 0.9 length of carpus; palm slightly expanding distally, 1.9 times as long as wide; upper margin carinate; lateral surface smooth; mesial surface slightly convex; lower margin sharply carinate, with row of setae extending onto fixed finger; fixed finger 0.75 times length of palm, slightly depressed; cutting edge obscurely denticulate proximally. Dactylus as long as fixed finger, slightly curved; upper margin with few tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge smooth.

Minor cheliped similar to major but more slender; carpus-palm upper margin slightly shorter than carapace length. Ischium upper margin smooth, lower margin with row of 9 spines. Merus about as long as ischium; with teeth as in major. Carpus 5 times as long as wide, elongate-triangular. Propodus

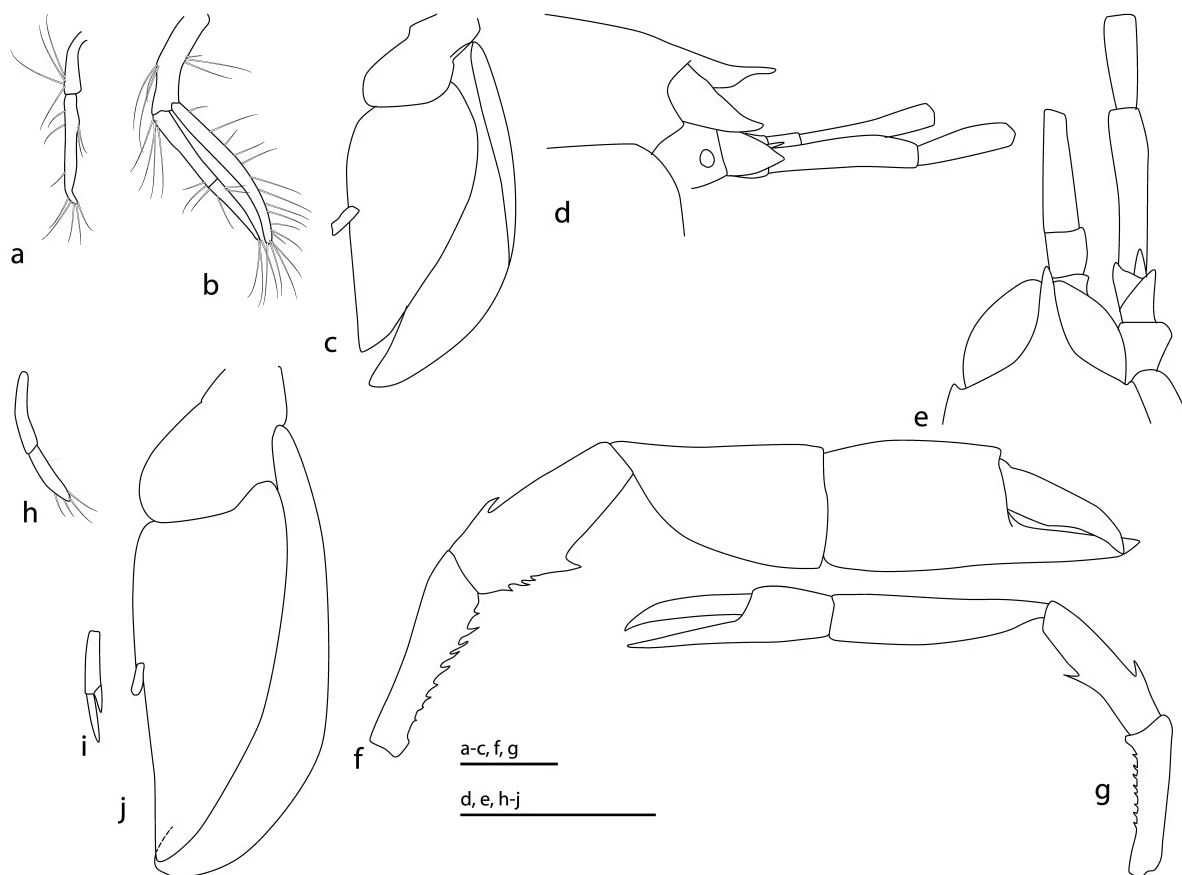


Figure 29. *Praedatrypaea lobetobensis* (De Man, 1905). Australia, Arafura Sea. AM P.74439, ovigerous female, 5.3 mm: a–c, pleopods 1–3. Papua New Guinea, MNHN IU-2015-109, male, 3.3 mm: d, e, anterior carapace, eyestalk, antennular, antennal peduncles (lateral); f, major cheliped (left mesial); g, minor cheliped (right, mesial); h–j, pleopods 1–3. Scale bars = 1 mm.

upper margin 0.35 times as long as carpus; palm slightly expanding distally, 1.9 times as long as wide; upper margin carinate; lateral surface smooth; mesial surface slightly convex; lower margin sharply carinate, with row of setae extending onto fixed finger; fixed finger as long as palm, not depressed; cutting edge smooth. Dactylus as long as fixed finger, slightly curved; cutting edge smooth.

Pereopod 2 merus with almost parallel margins, 4.1 times as long as wide; carpus subtriangular, 1.9 times as long as wide; chela subtriangular; palm twice as wide as upper margin; dactylus 3.3 times as long as palm upper margin. Pereopod 3 carpus subtriangular, twice as long as wide; propodus oval with slight produced lower proximal margin, upper margin 1.2 times width, lower margin convex; dactylus nearly straight, 0.75 length of propodus upper margin. Pereopod 4 coxa flattened ventrally, immovable; basis and ischium partially fused, extended posterolaterally; merus 1.2 times as long as ischium; carpus 0.65 length of merus; propodus as long as carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface; dactylus slightly curving, half as long as propodus. Pereopod 5 slender, with chela longer than carpus, slightly curving.

Female pleopod 1 of 2 articles. Female pleopod 2 subequally biramous; peduncle almost straight; exopod tapering distally, endopod of 2 articles. Pleopods 3–5 biramous, rami broad (endopod twice as long as wide); appendix interna slender, rod-like, projecting well beyond mesial margin of endopod, bearing coupling hooks on apical margin.

Uropod exopod only overreaching posterior margin of telson. Endopod about 1.6 times as long as wide, oval with straight anterior margin bearing 2 minute teeth, with 4 distal spiniform setae; upper surface without slender or spiniform setae; posterodistal margin convex, with fringe of setae. Exopod rectangular, with convex truncate distal margin, 1.7 times as long as wide, exceeding endopod by about one third length; anterior margin almost straight, without setae; posterior margin with numerous slender setae, with 10 blade-like distal setae, indistinguishably merged with distal margin; upper surface with 1 long seta; dorsal plate shorter than half exopod width, with row of about 6 stiff setae grading into/separated from setal row of distal margin.

Telson suboval, 1.4 times as long as wide, broadest anterior to anterolateral lobes, narrowing posteriorly to pair of posterior lobes separated by deep notch including median spine; dorsal surface with few medial setae anterior to midlength; posterolateral margin with 2 prominent curved spiniform setae.

**Male.** Rostrum not as deep as in female. Pereopods 1 (chelipeds) unequal, similar. Major cheliped linear, carpus-palm upper margin little shorter than carapace length. Ischium slightly expanding distally, upper margin straight, unarmed; lower margin with row of 8 spines, increasing in size distally. Merus about as long as ischium, 2.5 times as long as wide (spines excluded), slightly tapering distally; upper margin with 1 spine about one third way along; lower margin with oblique tooth near midpoint, smaller ones proximally. Carpus 1.7 times as long as wide, elongate-triangular; upper margin smooth; lower margin convex. Propodus upper margin 0.8 length of carpus; palm widest at midpoint, 1.3 times as long as wide; upper margin

carinate; lateral surface smooth; mesial surface slightly convex; lower margin sharply carinate, with row of setae extending onto fixed finger; fixed finger 0.7 length of palm, straight; cutting edge smooth. Dactylus as long as fixed finger, slightly curved; cutting edge smooth. Minor cheliped as in female. Pleopod 1 2-articled. Pleopod 2 biramous; endopod half as long as exopod.

**Distribution.** Western and Eastern Coral Triangle, Sahul Shelf, Northwest Australian Shelf (Papua New Guinea, Bismarck Sea; Indonesia, Banda Sea [type locality: Savu Sea, 8° 27' S, 122° 54.5' E, 247 m]; Australia, NT and WA, Arafura Sea to North West Shelf); 158–695 m.

**Remarks.** The holotype of *Praedatrypaea lobetobensis* is an ovigerous female with a more robust major cheliped than the females examined here; the lower margin of the merus of the major cheliped has four teeth along its proximal half, whereas these specimens have a single spine. These differences are attributed to larger size (cl. 5.9 mm) and maturity than the females examined here.

*Praedatrypaea lobetobensis* is one of two species in the genus with a tooth on the upper margin of the merus of both chelipeds, the other being *P. intermedia* (De Man, 1905). Both were described from eastern Indonesian deep water. They differ in the shape of the telson, that of *P. lobetobensis* having convex lateral margins converging on a pair of lobes (each as long as wide) separated by a narrow median notch, while that of *P. intermedia* has straight lateral margins converging on a pair of lobes (each shorter than wide) separated by a concave median notch.

### *Praedatrypaea mandu* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:82790EBF-E2B2-42CA-8F0B-C732F534E188>

Figures 30, 31

*Praedatrypaea propinqua*.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** Holotype. **Australia.** WA, Carnarvon Shelf, W of Mandu, Cape Range, 22.119°–22.121° S, 113.8424°–113.8418° E, 80 m (Geosciences Australia stn SOL4469\_1\_019\_MAPS02, 18 Jun 2008), NMV J59650\*# (ovigerous female, 2.6 mm). Paratypes, collected with holotype: NMV J59276 (male, 2.7 mm), NMV J72486 (female, incomplete, 2.8 mm), NMV J72487 (female, lacking pereopods 1–4, 2.8 mm). Other material. **Australia.** WA, northeastern North West Shelf to off Geraldton: 12.434° S, 123.601° E, 100 m (CSIRO stn SS05/2007/185), NMV J60030 (2); 19.79° S, 115.476° E, 102 m (CSIRO stn SS05/2007/24), NMV J60027 (ovigerous female, 2.8 mm; 3 males); 22.1188° S, 113.8209° E, 100 m (Geosciences Australia stn SOL4769\_1\_012\_MAPS01), NMV J71758 (3 males, 2.4–3.5 mm, no chelipeds); 22.8486° S, 113.511° E, 100 m (CSIRO stn SS10/2005/135), NMV J53453 (male, 3.2 mm; ovigerous female, 3.1 mm); 22.8514° S, 113.513° E, 100 m (CSIRO stn SS10/2005/136), NMV J60031 (4); 28.986° S, 113.836° E, 117 m (CSIRO stn SS07/2005/109), NMV J60356 (male, 2.7 mm).

**Diagnosis.** Antennular peduncle reaching distal margin of antennal peduncle article 5. Maxilliped 3 ischium about 1.55 times as long as wide; merus oval, about 1.5 times as wide as long, with tooth on convex distal margin. Chelipeds meri upper margins each unarmed. Major cheliped merus lower margin

with spine at midpoint; carpus 1.4 times as long as wide; palm 1.15 times as long as carpus, 1.35 times as long as wide; fingers, cutting edges with obsolete teeth. Uropod endopod twice as long as wide; anterior margin slightly convex, with 4 distal stout setae; distal-posterior margin tapered, oblique; dorsal face with irregular row of 5 or 6 spiniform setae close to anterior margin. Uropod exopod rectangular, truncate distally, twice as long as wide; anterior margin straight, setose. Telson 0.85 as long as wide, widest at strong lateral lobes at midpoint; posterior margin convex, with median spine; without spiniform setae on posterolateral margins. Male pleopods 1, 2 absent.

**Description. Female.** Rostrum acute, narrow in lateral and dorsal views, situated below level of dorsal carapace, as long as eyestalks. Carapace dorsally flat, as long as pleomeres 1, 2 and half pleomere 3 combined; orbital margin almost transverse; anterolateral lobes rounded; subanterolateral margin oblique; cervical groove across 0.8 length of carapace, shallow at midpoint, reaching linea thalassinica. Pleomere 1 tergite flat dorsally, wider posteriorly. Pleomere 2 about as wide as long. Pleomeres 3–5 each wider than long; pleura each with patch of

plumose setae. Pleomere 6 1.15 times as long as wide, 1.3 times as long as pleomere 5; with oblique shelf protruding from posteroventral margin.

Eyestalk about as long as wide, with oblique dorsal face diverging from rostrum, anterolateral margin evenly tapering, oblique, anteromedial angle rounded in dorsal view, not reaching distal margin of antennular peduncle article 1. Cornea densely pigmented, sitting in middle of eyestalk.

Antennular peduncle reaching distal margin of antennal peduncle article 5; article 1 visible in dorsal view; article 3 about as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 0.6 length of article 4; scaphocerite comma-shaped in dorsal view.

Maxilliped 3 ischium dilating over most of length, constricted distally, 1.55 times as long as wide, crista dentata consisting of row of about 25 uneven contiguous teeth; merus half as long as ischium measured along outer margin, about 1.5 times as wide as long, with mesiodistal margin evenly convex, with sharp mesially directed tooth; carpus about as long as merus outer margin; propodus tapering, 1.6 times as long as

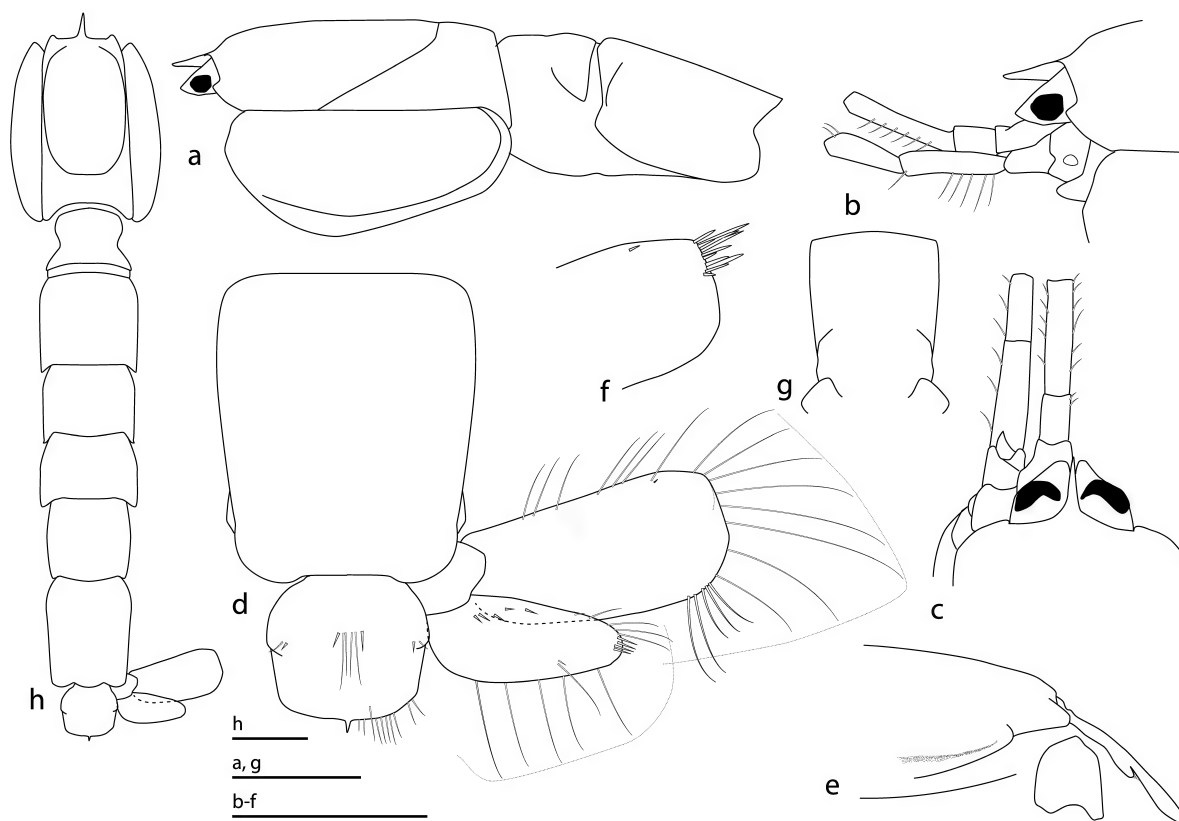


Figure 30. *Praeadatrypaea mandu* sp. nov. Australia, Carnarvon Shelf. NMV J59650, holotype female, 3.3 mm: a, carapace, eyestalk, pleomeres 1, 2; b, c, anterior carapace, eyestalks, antennular, antennal peduncles (lateral, dorsal views); d, pleomere 6, telson, right uropod; e, pleomere 6, telson, uropod peduncle (left lateral view); f, uropod exopod (distal half, dorsal plate); g, pleomere 6, bases of uropod peduncles (ventral view). NMV J59276, paratype male, 3.5 mm: h, carapace, pleon, telson, uropod. Scale bars = 1 mm.

greatest width; dactylus 0.7 length of propodus, elongate-oval, with dense row of short setae along flexor (lower) margin.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped carpus-palm upper margin 0.9 carapace length. Ischium expanding distally, upper margin unarmed; lower margin with 9 spines increasing in length distally. Merus as long as ischium, 2.2 times as long as wide (tooth excluded), oval; upper margin convex; lower margin with small tooth at about two thirds length. Carpus 1.4 times as long as wide. Propodus upper

margin 1.15 times as long as carpus; palm 1.35 times as long as wide; upper margin convex; lateral surface smooth, convex, with concave gape; mesial surface convex; lower margin with row of setae extending onto fixed finger; fixed finger about as long as palm; cutting edge with 2 low teeth. Dactylus as long as fixed finger, curved; cutting edge with 2 low teeth.

Minor cheliped carpus-palm upper margin 0.9 carapace length. Ischium lower margin with 9 spines increasing in length distally. Merus as long as ischium; upper margin

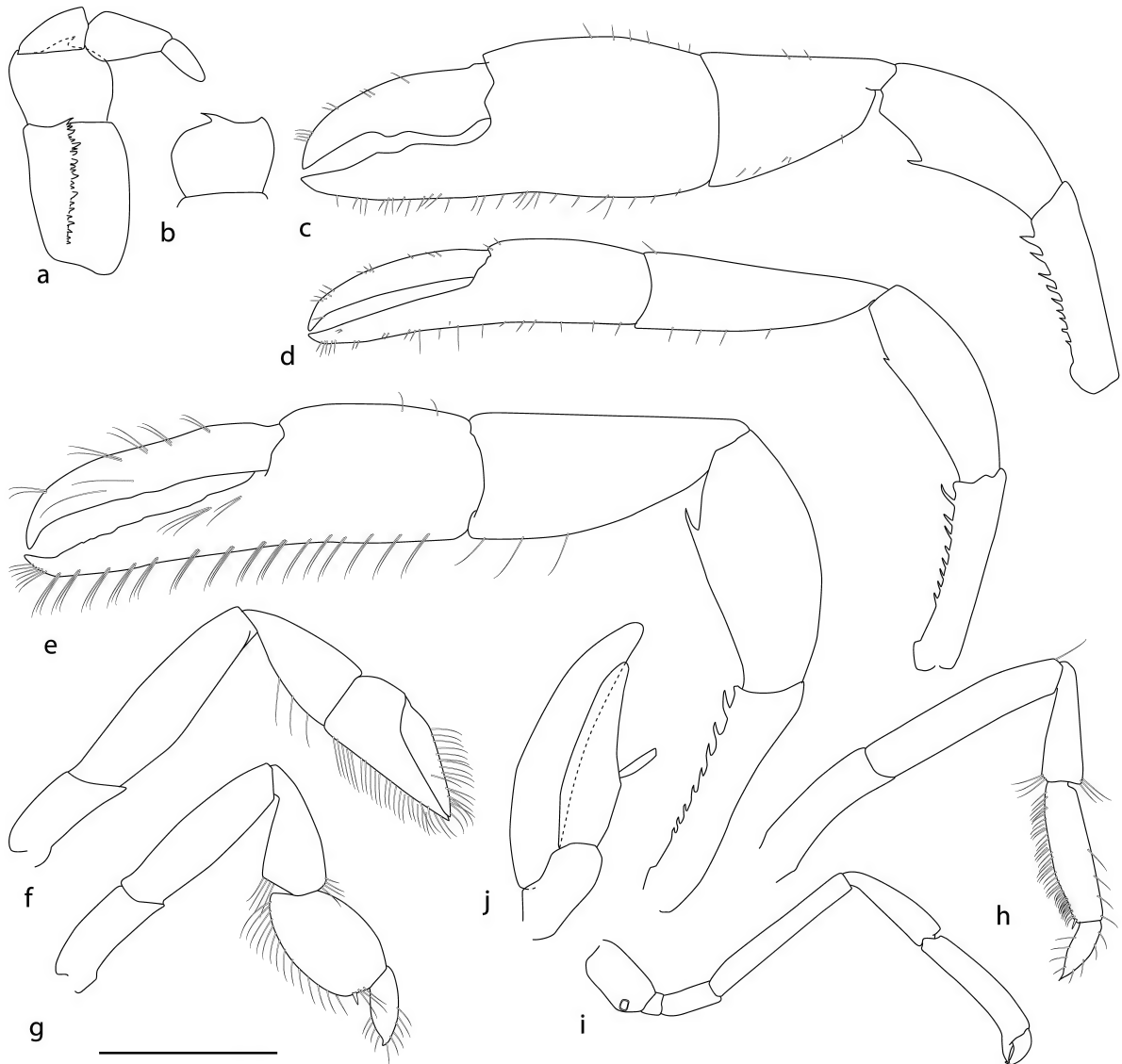


Figure 31. *Praedatrypaea mandu* sp. nov. Australia, Carnarvon Shelf. NMV J59650, holotype female, 3.3 mm: a, maxilliped 3 (inner view); b, maxilliped 3 merus (outer view); c, major cheliped (right, mesial view); d, minor cheliped (left, lateral view). NMV J59276, paratype male, 3.5 mm: e, minor cheliped (right, mesial view); f-i, pereopods 2-5; j, pleopod 3. Scale bar = 1 mm.

convex, smooth; lower margin with small distal tooth. Carpus dilating, 1.15 times as long as merus, 3 times as long as wide. Palm 0.6 length of carpus, twice long as wide; upper margin barely convex; lower margin carinate, with row of setae extending onto fixed finger; fixed finger longer than palm, cutting edge smooth. Dactylus longer than palm, curved distally; cutting edge smooth.

Pereopod 2 merus 3.8 times as long as wide; carpus twice as long as wide; chela subtriangular; palm 1.5 times as wide as upper margin; dactylus twice as long as palm upper margin. Pereopod 3 carpus subtriangular, twice as long as wide; propodus oval, longer than wide, with evenly curved lower margin, marginal setae evenly spaced, without gaps, with 1 short spiniform seta; dactylus 0.7 length of propodus upper margin. Pereopod 4 propodus longer than carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with short spiniform setae at base of dactylus; dactylus half as long as propodus. Pereopod 5 slender, chelate.

Pleopods 3–5 biramous, endopod 3.3 times as long as wide; appendix interna narrow, 0.25 length of endopod.

Uropod endopod and exopod well overreaching posterior margin of telson. Endopod subtriangular-oval, twice as long as wide; anterior margin slightly convex; anterodistal margin setose, with 4 subdistal spiniform setae; posterior margin with marginal setae; dorsal face with irregular row of 5 spiniform setae close to anterior margin. Exopod rectangular, truncate distally, twice as long as wide; anterior margin straight, setose; posterior margin with 5 falcate setae indistinguishably merged with densely setose distal margin; dorsal plate scarcely differentiated from distal margin, comprising about 12 short and medium stiff setae merging anteriorly with similar setae on distal margin; dorsal face with distal long seta and short spiniform seta near anterior margin.

Telson 1.15 times as wide as long, widest at strong lateral lobes at midpoint, narrowing posteriorly to rounded corner leading to transverse-convex posterior margin; posterior margin setose, with medial spine; lateral lobe with spiniform seta and long seta; transverse ridge with 1 pair of spiniform setae and long setae.

**Male.** Major cheliped unknown. Minor cheliped carpus-palm upper margin 0.9 carapace length. Ischium lower margin with 8 spines increasing in length distally. Merus almost as long as ischium; upper margin convex, smooth; lower margin with sharp distal tooth. Carpus 1.15 times as long as merus, 2.3 times as long as wide. Palm 0.65 length of carpus, 1.4 times long as wide; upper margin barely convex; lower margin carinate, with row of setae extending onto fixed finger; fixed finger 1.4 times as long as palm, cutting edge irregular. Dactylus longer than palm, curved distally; cutting edge smooth.

Pleopods 1 and 2 absent.

**Etymology.** From Mandu, a local name on Cape Range near the type locality (noun in apposition).

**Distribution.** Northwest Australian Shelf (Western Australia, northeastern North West Shelf to off Geraldton); 80–200 m.

**Remarks.** Two species of *Praedatrypaea* have been recorded from the North West Shelf of Australia: *Praedatrypaea*

*praedatrix* (De Man, 1905) by Sakai (1988) and *P. propinqua* (De Man, 1905) by Ngoc-Ho (1994); the latter was the name used erroneously in Robles et al.'s (2020) molecular study for a specimen from this region. Closer study reveals that the specimen from which tissue was taken is a new species, *P. mandu*, which differs from De Man's two species in having the peduncles of the antenna and antennule of similar lengths; the peduncles of the antenna are much longer in De Man's species. The telson of the new species is as long as wide, whereas those of De Man's species are longer than wide. The uropodal exopod of the new species is twice as long as wide but relatively wider in the other two species. The propodus of pereopod 3 is much narrower than that of the holotype of *P. propinqua* figured by De Man (1928a) and of that of material from New Caledonia (Ngoc-Ho, 1991).

The new species bears an uncanny resemblance to *C. brachytelson* Sakai, 2002 from the Andaman Sea, especially in the shape of the pleomere 6, telson, uropod and rostrum. Sakai's specimens lacked all pereopods. Sakai specifically noted the absence of a tooth on the merus of maxilliped 3, a feature of *P. mandu*.

### *Praedatrypaea modesta* (De Man, 1905)

*Callianassa* (*Calliactites*) *modesta* De Man, 1905: 604.—De Man, 1928: 26, 97, 118–124, pl. 10 fig. 16, pl. 11 fig. 16.

*Callianassa modesta*.—Liu and Zhong, 1994: 562.—Sakai, 1999: 48.—Komai, 2000: 345 (list).—Tudge et al., 2000: 143.—Sakai, 1999: 48–49.

*Cheramus modestus*.—Sakai, 2011: 369.

*Praedatrypaea modesta*.—Poore et al., 2019: 139, 143.

**Diagnosis.** Antennular peduncle reaching midpoint of antennal peduncle article 5. Maxilliped 3 ischium about as long as wide; merus rectangular, dilating, about 1.2 times as wide as long, with tooth on convex distal margin. Chelipeds meri upper margins each unarmed. Major cheliped merus lower margin with spine at midpoint; carpus about as long as wide; palm 1.7 times as long as carpus, about as long as wide; fingers, cutting edges with irregular teeth along cutting edges (more prominent on fixed finger of male). Uropod endopod 1.6 times as long as wide; anterior margin convex, with 4 distal stout setae; distal-posterior margin tapered, oblique; dorsal face with 3 long spiniform setae close to posterior margin. Uropod exopod oval, 1.7 times as long as wide; anterior margin convex, setose. Telson as long as wide, widest at strong lateral lobes at one-third length; posterior margin convex, with median spine; with 2 pairs of spiniform setae on posterolateral margins. Male pleopod 1 2-articled; pleopod 2 biramous.

**Distribution.** South China Sea, Sunda Shelf (Southern China, Philippines, Malaysia, Indonesia [type locality: Elat, W coast Kai Besar, 27 m]); 27–310 m.

**Remarks.** De Man (1905) listed 12 specimens from four *Siboga* stations in Indonesia, from 27 to 310 m depth. De Man (1928a: 124) selected the largest female from *Siboga* stn 261 (Elat, west coast of "Great-Kei-Island" [Kai Besar], 27 m) as the lectotype. Sakai's subsequent (1999) lectotype designation of a male from *Siboga* stn 116 was unnecessary.

This diagnosis was based on De Man's (1928) figures supplemented by sketches of males and females from the Gulf

of Siam, Malaysia (ZMUC CRU-3832–CRU-3836; recatalogued in part as NHMD 81684) and from the MNHN Panglao expedition to the Philippines kindly shared by Peter C. Dworschak (pers. comm., 15 Jun 2018). *Praedatrypaea modesta* differs from others in the possession of three long facial spiniform setae near the posterodistal margin of the uropodal endopod and a rectangular (not oval) pereopod 3 propodus. The species is notable for the strong irregular teeth on the male major cheliped.

***Praedatrypaea ningaloo* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:9B78B4B5-0385-4AB5-AF1D-82F8C664CA6E>

**Figure 32**

*Callianassa* sp. MoV 4966.—Poore et al., 2008: 94.

**Material examined.** Holotype. **Australia**, North West Shelf, off Ningaloo North, 21.9781° S, 113.837° E, 106 m (CSIRO stn SS10/2005/162), NMV J53459 (female, 4.4 mm).

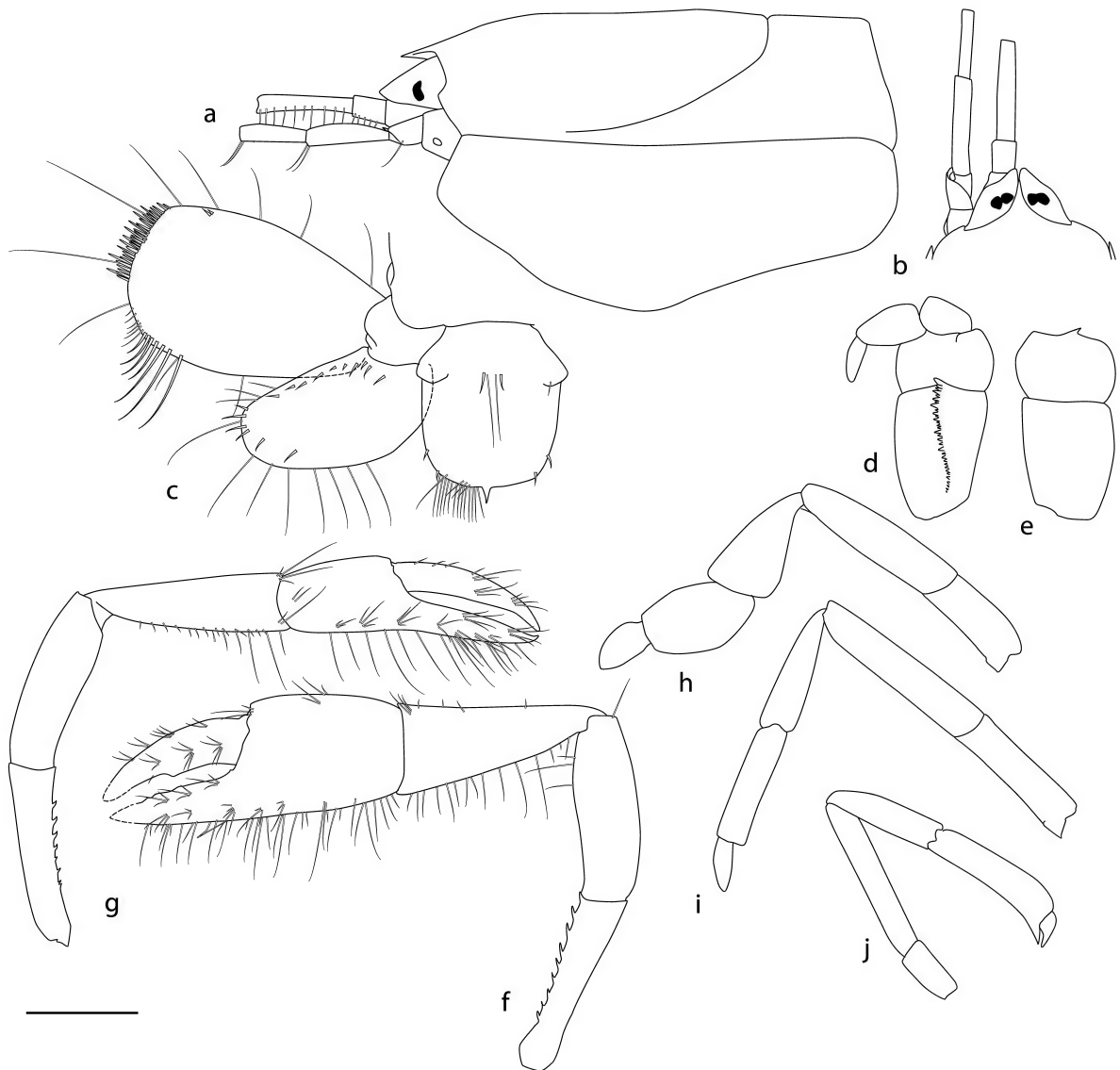


Figure 32. *Praedatrypaea ningaloo* sp. nov. Australia, North West Shelf. NMV J53459, holotype female, 4.4 mm: a, b, anterior carapace, eyestalks, antennular, antennal peduncles (lateral, dorsal views); c, pleomere 6, telson, left uropod; d, maxilliped 3 (inner view); e, maxilliped 3 ischium, merus (outer view); f, major cheliped (left, lateral view); g, minor cheliped (right, lateral view); h–j, pereopods 3–5. Scale bar = 1 mm.

**Diagnosis.** Antennular peduncle reaching midpoint of antennal peduncle article 5. Maxilliped 3 ischium about 1.3 times as long as wide; merus oval, about 1.5 times as wide as long, with tooth on convex distal margin. Chelipeds meri upper margins each unarmed. Major cheliped merus lower margin without spine at midpoint; carpus 2.3 times as long as wide; palm 1.7 times as long as carpus, 1.3 times as long as wide; fingers, cutting edges with obsolete teeth. Uropod endopod 1.4 times as long as wide; anterior margin straight, with 4 distal spiniform setae; distal-posterior margin evenly curved; dorsal face with curved row of 10 spiniform setae close to anterior margin, 2 more near posterodistal margin. Uropod exopod ovate, truncate distally, 1.7 times as long as wide; anterior margin convex, setose. Telson 1.1 times as long as wide, widest at strong lateral lobes at one-third length; posterior margin convex, with median spine; with 2 pairs of spiniform setae on posterolateral margins. Male pleopods 1, 2 unknown.

**Description. Female.** Rostrum acutely triangular in dorsal view, situated below level of dorsal carapace, 0.7 length of eyestalks. Carapace dorsally flat, as long as pleomeres 1, 2 combined; orbital margin oblique; anterolateral lobes rounded; subanterolateral margin oblique; cervical groove across 0.8 length of carapace, shallow at midpoint, almost reaching linea thalassinica.

Eyestalk about as long as wide, subtriangular in dorsal view, with oblique dorsal face diverging from rostrum, anterolateral margin slightly concave, oblique, anteromedial angle rounded in dorsal view, reaching distal margin of antennular peduncle article 1. Cornea densely pigmented, sitting proximally on eyestalk.

Antennular peduncle reaching midpoint of margin of antennal peduncle article 5; article 1 barely visible in dorsal view; article 3 longer than articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 0.7 length of article 4; scaphocerite comma-shaped in dorsal view.

Maxilliped 3 ischium dilating over most of length, 1.3 times as long as wide, crista dentata consisting of row of about 35 uneven contiguous teeth; merus 0.65 length of ischium measured along outer margin, about 1.5 times as wide as long, with mesiodistal margin convex, with sharp mesially directed tooth; carpus little shorter than merus outer margin; propodus tapering, 1.7 times as long as greatest width; dactylus 0.65 length of propodus, elongate-oval, with dense row of short setae along flexor (lower) margin.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped carpus-palm upper margin 0.8 carapace length. Ischium expanding distally, upper margin unarmed; lower margin with 8 spines increasing in length distally. Merus as long as ischium, 2.9 times as long as wide; upper margin convex; lower margin unarmed. Carpus 2.3 times as long as wide. Propodus upper margin 0.7 length of carpus; palm 1.3 times as long as wide; upper margin convex; lateral surface smooth, convex; mesial surface convex; lower margin with row of setae extending onto fixed finger; fixed finger about as long as palm; cutting edge irregular. Dactylus as long as fixed finger, curved; cutting edge with 1 low step-like tooth.

Minor cheliped carpus-palm upper margin 0.7 carapace length. Ischium lower margin with 7 spines increasing in length distally. Merus as long as ischium; upper margin convex, smooth; lower margin unarmed. Carpus dilating, as long as merus, 3.4 times as long as wide. Palm half as long as carpus, 1.4 times long as wide; upper margin barely convex; lower margin carinate, with row of setae extending onto fixed finger; fixed finger longer than palm, cutting edge smooth. Dactylus longer than palm, curved distally; cutting edge smooth.

Pereopod 3 carpus subtriangular, twice as long as wide; propodus oval, longer than wide, with evenly curved lower margin, marginal setae evenly spaced, without gaps, with 1 short spiniform seta; dactylus 0.7 length of propodus upper margin. Pereopod 4 propodus as long as carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with short spiniform setae at base of dactylus; dactylus half as long as propodus. Pereopod 5 slender, chelate.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod suboval, 1.4 times as long as wide; anterior margin almost straight; anterodistal margin setose, with 4 subdistal spiniform setae; posterior margin with marginal setae; dorsal face with curved row of 10 spiniform setae close to anterior margin, 2 more near posterodistal margin. Exopod ovate, truncate distally, 1.7 times as long as wide; anterior margin convex; posterior margin with 7 falcate setae indistinguishably merged with densely setose distal margin; dorsal plate scarcely indistinguishable from distal margin, comprising short and medium stiff setae merging anteriorly with similar setae on distal margin; dorsal face with 2 short spiniform setae near anterior margin.

Telson 1.1 times as wide as long, widest at strong lateral lobes at one third length, narrowing posteriorly without angle to convex posterior margin; posterolateral margin with 2 spiniform setae; posterior margin setose, with medial spine; lateral lobe with short seta; transverse dorsal ridge with 1 pair of spiniform setae and long setae.

**Etymology.** From Ningaloo, name of the barrier reef near the type locality (noun in apposition).

**Distribution.** Northwest Australian Shelf (Western Australia, off Ningaloo; known only from the type locality); 106 m.

**Remarks.** The single female of *P. ningaloo* differs significantly from the two other species found on the Australian North West Shelf. Notably, the carpus of the major cheliped is more than twice as long as wide (about as wide as long in *P. mandu* and *P. propinqua*), the uropodal endopod has 12 facial spiniform setae in an irregular row close to the anterior and distoposterior margin (3 or 4 in a group in the other two species), and the uropodal exopod is ovate, 1.7 times as long as wide (more rectangular and narrower in the other two species). The dorsal armature of the uropodal endopod (several spiniform setae in a longitudinal row) of *Praedatrypaea ningaloo* resembles that of *P. praedatrix*, but the shorter antenna and the major cheliped with its elongate merus and carpus differ.

***Praedatrypaea orientalis* (Bate, 1888) comb. nov.**

Figures 1e, 33, 34

*Cheramus orientalis* Bate, 1888: 30, pl. 1 fig. 2.—Tudge et al., 2000: 145.—Sakai, 2011: 370.—Holthuis, 1991: 239 (type species designation of *Cheramus* – q.v. above).

*Callianassa (Cheramus) orientalis*.—Borradaile, 1903: 546.—De Man, 1928b: 9, pl. 1 fig. 2, 2a.—De Man, 1928a: 26, 93, 98, 119, 132, 137.

*Callianassa orientalis*.—Sakai, 1999: 49, fig. 5.—Sakai, 2005: 20, 95.

*Callianassa malaccaensis* Sakai, 2002: 492–496, figs 18, 19.—Sakai, 2005: 91–92. **Syn. nov.**

*Cheramus malaccaensis*.—Sakai, 2011: 368.

*Pugnatrypaea orientalis*.—Poore et al., 2019: 139, 143.

**Material examined.** **Australia**, NT, Arafura Sea, 9° 50.466' S, 135° 16.099' E, 80 m, muddy sand (CSIRO stn SS05/2005/005/GR006), AM P.74440 (male, 5.9 mm). 9° 22.63' S, 134° 12.83' E, 106 m, sandy mud (CSIRO stn SS05/2005/015/GR025), AM P.74441A (male, 6.5 mm). 9° 49.933' S, 135° 19.656' E, 83 m, calcareous mud (CSIRO stn SS05/2005/008/GR013), AM P.74444 (female, 3.5 mm). 9° 22.66' S, 134° 12.87' E, 70 m, sandy mud (CSIRO stn SS05/2005/015/BS004), AM P.74472 (male, 5.9 mm). 9° 48.774' S, 135° 15.412' E, 82 m, (CSIRO stn SS05/2005/010/GR017), AM P.74473 (female, 5.10 mm). 9° 47.593' S, 135° 16.636' E, 85 m, muddy sand (CSIRO stn SS05/2005/012/GR019), AM P.74476 (male, 3.5 mm; female, 3.3 mm). 9° 47.992' S, 135° 22.001' E, 92 m, calcareous mud (CSIRO stn SS05/2005/002/GR001), AM P.74477 (male, 4.9 mm). 9° 50.361' S, 135° 20.904' E, 87 m, muddy sand (CSIRO stn SS05/2005/006/GR008), AM P.74479 (female without chelipeds, 5.9 mm); 9° 47.986' S, 135° 22.007' E, 91 m, calcareous mud (CSIRO stn SS05/2005/002/GR002), AM P.74449 (1 incomplete); 9° 47.768' S, 135° 16.935' E, 84 m, rippled sand (CSIRO stn SS05/2005/011/GR018), AM P.74446 (2 females, incomplete, 3.1, 3.9 mm).

**Diagnosis.** Antennular peduncle reaching midpoint of antennal peduncle article 5. Maxilliped 3 ischium about twice as long as wide; merus oval, about as wide as long, without tooth on oblique margin. Chelipeds meri upper margins each unarmed. Major cheliped merus lower margin with spine at midpoint and few smaller proximal teeth in female, with spine at midpoint or row of teeth in male; carpus about as long as wide or longer than wide; palm 1.25 times as long as carpus, 1.2 times as long as wide; fingers, cutting edges with obsolete teeth in female, with irregular teeth in male. Uropod endopod 1.6 times as long as wide; anterior margin straight, with 5 distal spiniform setae; distal-posterior margin strongly convex distally; dorsal face with row of 5 spiniform setae close to anterior margin. Uropod exopod rectangular, truncate distally, 1.5 times as long as wide; anterior margin straight, not setose. Telson 1.15 times as long as wide, widest at strong lateral lobes at one-third length; posterior margin with shallow medial depression, with medial spine; with 2 pairs of spiniform setae on posterolateral margins. Male pleopod 1 2-articled; pleopod 2 biramous.

**Supplementary description.** **Male.** Rostrum acutely triangular in dorsal view, situated at level of dorsal carapace, 0.8 length of eyestalks. Carapace dorsally flat, as long as pleomeres 1–3 combined; orbital margin oblique; anterolateral lobes rounded; subanterolateral margin oblique; cervical groove across 0.75 length of carapace, shallow at midpoint, almost reaching linea thalassinica.

Eyestalk 1.2 times as long as wide, almost quadrant-shaped in dorsal view, with oblique dorsal face diverging from rostrum, anterolateral margin concave, anteromedial angle rounded in dorsal view, nearly reaching distal margin of antennular peduncle article 1. Cornea densely pigmented, sitting near middle of eyestalk.

Antennular peduncle reaching near midpoint of antennal peduncle article 5; article 1 barely visible in dorsal view; article 3 longer than articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae.

Antennal peduncle article 5 0.6–0.7 length of article 4; scaphocerite comma-shaped in dorsal view.

Maxilliped 3 ischium almost parallel-sided over most of length, twice as long as wide, crista dentata consisting of row of about 20 uneven contiguous teeth; merus 0.6 length of ischium measured along outer margin, about as wide as long, with mesiodistal margin convex, oblique, without tooth; carpus little shorter than merus outer margin; propodus tapering, 1.4 times as long as greatest width; dactylus 0.75 length of propodus, elongate-oval, with dense row of short setae along flexor (lower) margin.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped carpus-palm upper margin 0.9 carapace length. Ischium expanding distally, upper margin unarmed; lower margin with 6 similar spines over middle third. Merus as long as ischium, 1.8 times as long as wide; upper margin convex; lower margin convex, with spine at midpoint or with 7 evenly spaced spines. Carpus about as long as wide. Propodus upper margin 1.2 times as long as carpus; palm about as long as wide; upper margin convex; lateral surface smooth, convex; mesial surface convex, with blunt boss or bifid tooth proximal to gape; lower margin with row of setae extending onto fixed finger; fixed finger two thirds as long as palm; cutting edge with irregular teeth over proximal half. Dactylus as long as fixed finger, curved; cutting edge with broad subproximal tooth, irregular crenellations over middle third.

Minor cheliped carpus-palm upper margin 0.65 carapace length. Ischium lower margin with minute teeth. Merus as long as ischium; upper margin convex, smooth; lower margin with tooth beyond midpoint. Carpus dilating, 1.6 times as long as merus, about 4 times as long as wide. Palm 0.4 times as long as carpus, 1.5 times long as wide; upper margin barely convex; lower margin carinate, with row of setae extending onto fixed finger; fixed finger longer than palm, cutting edge smooth. Dactylus about as long as palm, curved; cutting edge smooth.

Pereopod 2 merus 3.3 times as long as wide; carpus 1.7 times as long as wide; chela subtriangular; palm twice as wide as upper margin; dactylus 2.8 times as long as palm upper margin. Pereopod 3 carpus oval, 2.4 times as long as wide; propodus oval, 1.7 times as wide, with evenly curved lower margin, marginal setae in groups separated by gaps, with 1 short spiniform seta; dactylus 0.75 length of propodus upper margin. Pereopod 4 propodus longer than carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with short spiniform setae at base of dactylus; dactylus half as long as propodus. Pereopod 5 chelate.



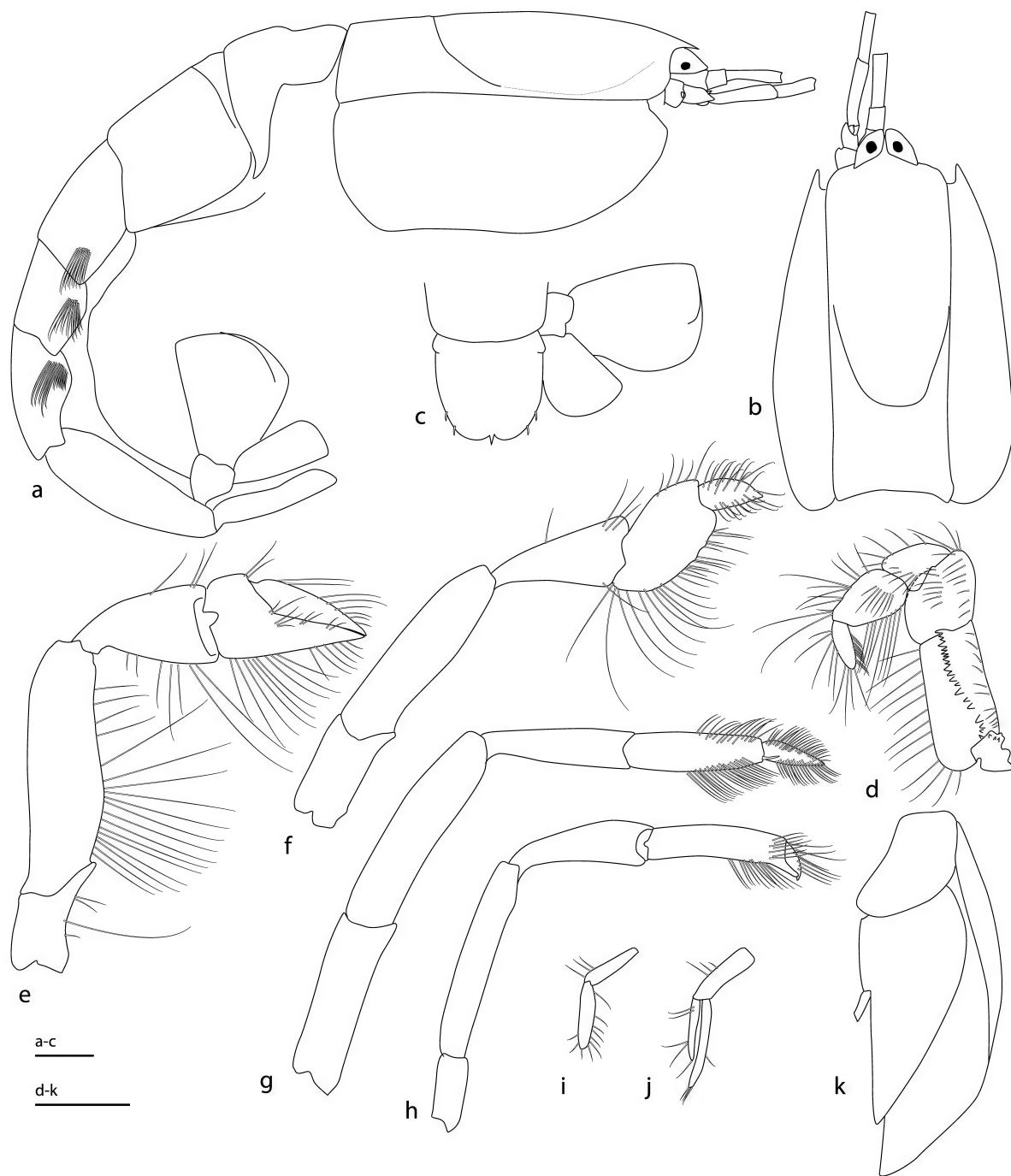


Figure 33. *Praedatrypaea orientalis* (Bate, 1888). Australia, Arafura Sea. AM P.74479, female, 5.9 mm: a, antennular, antennal peduncles, eyestalk, carapace, pleon, uropod (lateral); b, antennular, antennal peduncles, eyestalk, carapace (dorsal); c, telson, right uropod (setae not figured); d, maxilliped 3 (inner face); e–h, pereopods 2–5; i–k, pleopods 1–3. Scale bars = 1 mm.

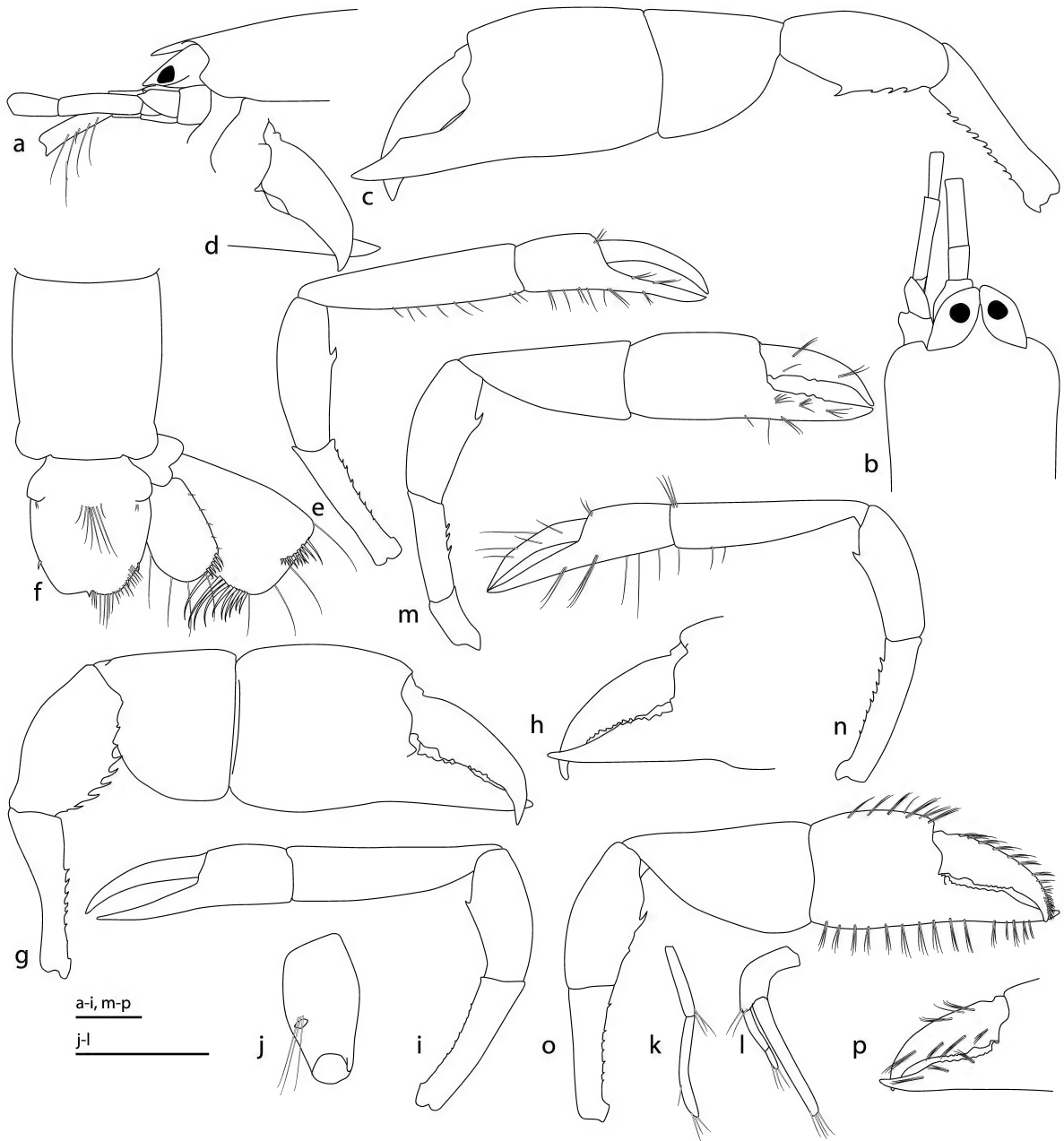


Figure 34. *Praedatrypaea orientalis* (Bate, 1888). Australia, Arafura Sea. AM P.74444, female, 5.9 mm: a, antennular, antennal peduncles, eyestalk, carapace (lateral); b, antennular, antennal peduncles, eyestalk, carapace (dorsal); c, major cheliped (right, mesial); d, major cheliped fingers (lateral); e, minor cheliped (left, mesial). AM P.74440, male, 5.9 mm: f, pleomere 6, telson, right uropod; g, major cheliped (left, mesial); h, major cheliped fingers (lateral); i, minor cheliped (right, mesial); j, pereopod 5 coxa (mesial); k, l, pleopods 1, 2. AM P.74476, male, 3.5 mm: m, major cheliped (left, mesial); n, minor cheliped (right, mesial). AM P.74472, male, 5.9 mm: o, major cheliped (left, mesial); p, major cheliped fingers (lateral). Scale bars = 1 mm.

Male pleopod 1 short, narrow. Pleopod 2 with endopod shorter than exopod.

Uropod endopod and exopod reaching posterior margin of telson. Endopod suboval, 1.6 times as long as wide; anterior margin almost straight; anterodistal margin setose, with 5 subdistal spiniform setae; posterior margin with marginal setae; dorsal face with row of 5 well-spaced short setae close to anterior margin. Exopod rectangular, truncate distally, 1.5 times as long as wide; anterior margin straight, not setose; posterior margin with 9 falcate setae indistinguishably merged with densely setose distal margin; dorsal plate scarcely indistinguishable from distal margin, comprising short and medium stiff setae merging anteriorly with similar setae on distal margin; dorsal face without spiniform setae.

Telson 1.15 times as long as wide, widest at strong lateral lobes at one third length, narrowing posteriorly without angle to paired convex posterior margin with medial notch bearing medial spine; with 2 pairs of spiniform setae on posterolateral margin; lateral lobe with 2 short setae posterior; transverse dorsal ridge with long setae.

**Variation.** The major cheliped of smaller males is less well developed, narrower and with obsolete teeth on the fingers (cf. fig. 34m with fig. 34g, k). The major cheliped merus of the two largest males differ, one with a row of teeth along the lower margin, the other with one prominent tooth and minute teeth (cf. fig. 34g, o). The major cheliped of the female has fewer teeth on the lower margin of the merus and simpler dentition on the fingers (fig. 34c, d).

**Distribution.** Sahul Shelf (Australia, NT, Arafura Sea); 51–106 m.

**Remarks.** The holotype of *Cheramus orientalis* Bate, 1888 is from the eastern Arafura Sea (9° 59' S, 139° 42' E, 28 fm [51 m]), very close to this new collection. Bate's description and figures are sketchy and can not be relied on. W.T. Calman's figures of the telson, uropod and maxilliped 3 of the holotype were included in De Man (1928a) and the carapace, pleomere 6, telson and uropod of the holotype were figured by Sakai (1999); all figures are consistent with the new material. Bate's holotype lacks chelipeds and other pereopods which are described and figured here. *Cheramus orientalis* Bate, 1888 was listed by Poore et al. (2019) as a member of *Pugnatrypaea*, mainly because it lacks the tooth on the merus of maxilliped 3 present in other species of *Praedatrypaea*. The telson does not have the deep posterior notch characteristic of *Pugnatrypaea*. Illustrations of *Pugnatrypaea ruiyui* Liu, 2022, from the northern South China Sea, are virtually identical to those of *Praedatrypaea orientalis* presented here. For the time being, it is treated as *Praedatrypaea ruiyui* (Liu, 2022) **comb. nov.**

*Callianassa malaccaensis* Sakai, 2002 is probably a synonym of *P. orientalis*. Sakai (2002) recognised the similarity between the two species, noting only slight differences in the relative lengths of the antennular and antennal peduncles and shape of the uropodal exopod, differences that appear within species variability. The telson, uropod, maxilliped 3, eyestalk, and antennae are quite similar. If so, the species range would extend into the Andaman Sea at similar depths.

### *Praedatrypaea praedatrix* (De Man, 1905)

Figure 35

*Callianassa praedatrix* De Man, 1905: 607–608.—Ngoc-Ho, 1994: fig. 2a–c (holotype).—Sakai, 1999: 51.—Sakai, 2005: 100.

*Callianassa (Cheramus) praedatrix*.—De Man, 1928a: 26, 97, 99, 146–151, pl. 15 fig. 22.

*Callianassa praedatrix*.—Sakai, 1988: 59–61, fig. 4.

*Cheramus praedatrix*.—Tudge et al., 2000: 145.—Sakai, 2011: 370–371.

*Praedatrypaea praedatrix*.—Poore et al., 2019: 139, 143.—Robles et al., 2020: figs 1, 3, 6.—Dworschak, 2022: 252–253, fig. 1.

**Material examined.** **Egypt**, Dahab Lagoon, 28.48° S, 34.49° E, NHMW 24324 (ULLZ 10129)\* (ovigerous female, 6.8 mm).

**Diagnosis.** Antennular peduncle reaching distal margin of antennal peduncle article 4. Maxilliped 3 ischium about 1.3 times as long as wide; merus oval, about 1.5 times as wide as long, with tooth on convex distal margin. Chelipeds meri upper margins each unarmed. Major cheliped merus lower margin with spine at midpoint, or with row of teeth; carpus 0.6 times as long as wide; palm 2.2 times as long as carpus, 1.2 times as long as wide; fingers, cutting edges with obsolete teeth. Uropod endopod 1.5 times as long as wide; anterior margin convex, with 4 distal stout setae; distal-posterior margin truncate distally, convex posteriorly; dorsal face with irregular row of 6 spiniform setae close to anterior margin, 1+3 spiniform setae close to posterodistal angle. Uropod exopod rectangular-oval, truncate distally, 1.5 times as long as wide; anterior margin straight, setose. Telson 1.3 times as long as wide, widest at strong lateral lobes at one third length; posterior margin with shallow medial depression, with medial spine; with 2 pairs of spiniform setae on posterolateral margins. Male pleopods 1, 2 unknown.

**Distribution.** Western Coral Triangle, Northwest Australian Shelf (Indonesia [type locality: Boton Strait, 75–94 m]; North West Shelf, Australia); 76–94 m. Other records doubtful.

**Remarks.** *Callianassa praedatrix* was described from a single female from Boton Strait, Indonesia. Tissue from a female from Egypt was identified as this species and contributed to the molecular treatment of Robles et al. (2020) and later figured by Dworschak (2022: fig. 1). Although taken far from the type locality, Dworschak (2022) identified the female based on the maxilliped 3, pleomere 6, uropods and pereopod 3. While the shape and setation of the uropodal rami of the Egyptian female are much as in De Man's (1928b) figure, the posterior of the telson is more rounded (Dworschak, 2022: fig. 1h) than truncate (De Man, 1928b: pl. 15 fig. 22; Ngoc-Ho, 1994: fig. 2). The identity of the Egyptian female is questionable.

Davie (2002) included the species in the Australian fauna based on Sakai's (1988) record of an ovigerous female lacking chelipeds and pleomere 6 and tailfan of *C. praedatrix* De Man, 1905 (now *Praedatrypaea praedatrix*) from the North West Shelf. His figures of the maxilliped 3 and pereopod 3 (relatively wider and narrower respectively than *P. propinqua*) support his identification.

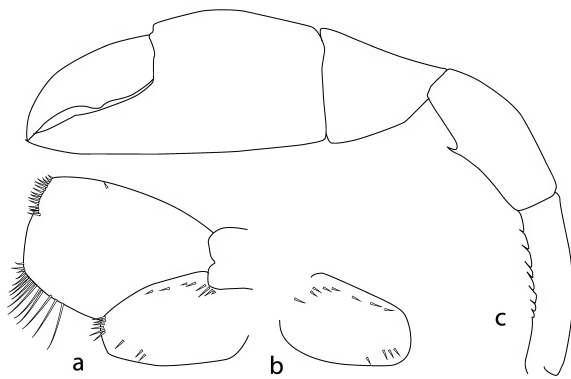


Figure 35. *Praedatrypaea praedatrix* (De Man, 1905). Egypt. NHMW 24324, ovigerous female, 6.8 mm: a, left uropod; b, right uropodal endopod; c, major cheliped (right, mesial view). Same scale.

### *Praedatrypaea propinqua* (De Man, 1905)

Figure 36

*Callianassa propinqua* De Man, 1905: 609.—Ngoc-Ho, 1991: 290–292, fig. 4.—Sakai, 1999: 51.—Sakai, 2005: 100–101.

*Callianassa (Cheramus) propinqua*.—De Man, 1928a: 27, 98, 127, pl. 12 fig. 18.

*Callianassa propinqua*.—Ngoc-Ho, 1994: 54, fig. 2d–f.

*Cheramus propinquus*.—Tudge et al., 2000: 145.—Davie, 2002: 459.—Sakai, 2011: 371–372.

*Lipkecallianassa* sp. MoV 4960.—Poore et al., 2008: 96.

*Praedatrypaea propinqua*.—Poore et al., 2019: 139, 143.

**Material examined.** **Papua New Guinea**, off Cape Croisilles, 04° 53' S, 145° 49' E, 370 m (PAPUA NIUGINI stn DW4031), MNHN IU-2013-12310 (female, 5.0 mm). **Australia** WA, North West Shelf, between Timor Sea and off Ningaloo: 12.434° S, 123.601° E, 100 m (CSIRO stn SS05/2007/185), NMV J60028 (juvenile); 12.434° S, 123.601° E, 100 m (CSIRO stn SS05/2007/186), NMV J60033 (2 females, 1.0 mm); 17.4408° S, 120.439° E, 200 m (CSIRO stn SS05/2007/94), NMV J60029 (female, 3.1 mm); 18° 50' S, 117° 39' E, 178 m (MV stn NWA 29), NMV J22660 (male, 2.1 mm; ovigerous female, 2.8 mm), 19° 5' S, 117° 26' E, 120 m (MV stn NWA 52), NMV J22661 (2 females, 2.8 mm); 19.7503° S, 115.367° E, 200 m (CSIRO stn SS05/2007/32), NMV J60026 (female, 3.9 mm); 21.986° S, 113.82° E, 165 m (CSIRO stn SS10/2005/153), NMV J53451 (ovigerous female, 3.8 mm); 22.079° S, 113.796° E, 201–206 m (CSIRO stn SS10/2005/146), NMV J53452 (4 females, 3.6 mm [one with Bopyridae in branchial chamber]); NMV J71760 (male, 4.0 mm).

**Diagnosis.** Antennular peduncle reaching midpoint of antennal peduncle article 5. Maxilliped 3 ischium about twice as long as wide; merus with lobed mesiodistal corner, about 1.2 times as wide as long, with tooth on convex distal margin. Chelipeds meri upper margins each unarmed. Major cheliped merus lower margin with spine at midpoint; carpus 1.0–1.2 times as long as wide; palm 1.4–1.7 times as long as carpus, 1.3–1.4 times as long as wide; fingers, cutting edges with obsolete teeth. Uropod endopod 1.5–1.7 times as long as wide; anterior margin convex, with two distal stout setae; distal-posterior

margin not differentiated from anterior margin, more convex distally; dorsal face with row of three (rarely four) spiniform setae proximally and close to anterior margin. Uropod exopod rectangular, truncate distally, 1.6–1.9 times as long as wide; anterior margin straight, setose. Telson 1.2–1.3 times as long as wide, widest at strong lateral lobes at about one quarter length; posterior margin convex, with median spine; with two pairs of spiniform setae on posterolateral margins. Male pleopod 1 2-articled or filiform; pleopod 2 biramous or minuscule.

**Distribution.** Tropical Southwestern Pacific, Western and Eastern Coral Triangle, Sahul Shelf, Northwest Australian Shelf (New Caledonia; Indonesia [type locality: North Sulawesi, Kwandang Bay, 75 m]; Papua New Guinea; Australia, northwestern WA); 75–300 m.

**Remarks.** *Callianassa propinqua* was described from Kwandang, North Sulawesi, Indonesia at 75 m (De Man, 1905) and has been subsequently reported from New Caledonia (Ngoc-Ho, 1991) and the North West Shelf of Australia (Ngoc-Ho, 1994), where it seems relatively common. Some of the ratios of and between articles used to diagnose the species are variable between individuals.

The male from New Caledonia differs from the Indonesian and Australian specimens in having several teeth along the lower margin of the major cheliped merus and a rounder merus of maxilliped 3. This male possesses a two-articled male pleopod 1 and a biramous pleopod 2; the only male from Australia has a filiform pleopod and minuscule bud-like pleopod 2 (fig. 36h).

### *Pugnatrypaea* Poore, Dworschak, Robles, Mantelatto and Felder, 2019

*Pugnatrypaea* Poore et al., 2019: 97–98.—Robles et al., 2020: figs 1, 3, 6.—Poore and Ahyong, 2023: 213.

**Diagnosis.** Rostrum acute, anteriorly directed, almost as long as eyestalks. Pleomere 1 tergite fused, divided into 2 sections by transverse step. Pleomere 6 flared posteriorly. Cornea with scattered reduced pigmentation. Antennular peduncle exceeded by all of antennal peduncular article 5 or not exceeding article 5; articles 2 and 3 with single lateral row of well-spaced long setae along lower margin. Antennal scaphocerite simple, longer than wide, acute. Maxilliped 3 merus distally almost transverse with obtuse angle between distal and mesial margins, as long as or longer than wide at ischium-merus suture, without distal spine on distal free margin. Male major cheliped merus with simple proximal hook on lower margin. Pereopod 3 propodus oval, lower margin convex, leading to narrow sharply rounded proximal lobe. Male pleopod 2 present or absent. Uropodal endopod ovoid, longer than wide, anterior margin straight, posterodistal margin evenly convex, with long facial spiniform setae on rib. Uropodal exopod about 1.8 times as long as wide, distal margin clearly differentiated from anterior margin, anterodistal corner right-angled, posterodistal margin with row of 6–8 long blade-like setae proximal to long setae on distal margin. Telson anterolateral lobe obsolete, undefined; telson tapering over distal third to pair of lobes separated by deep notch, with medial spine.

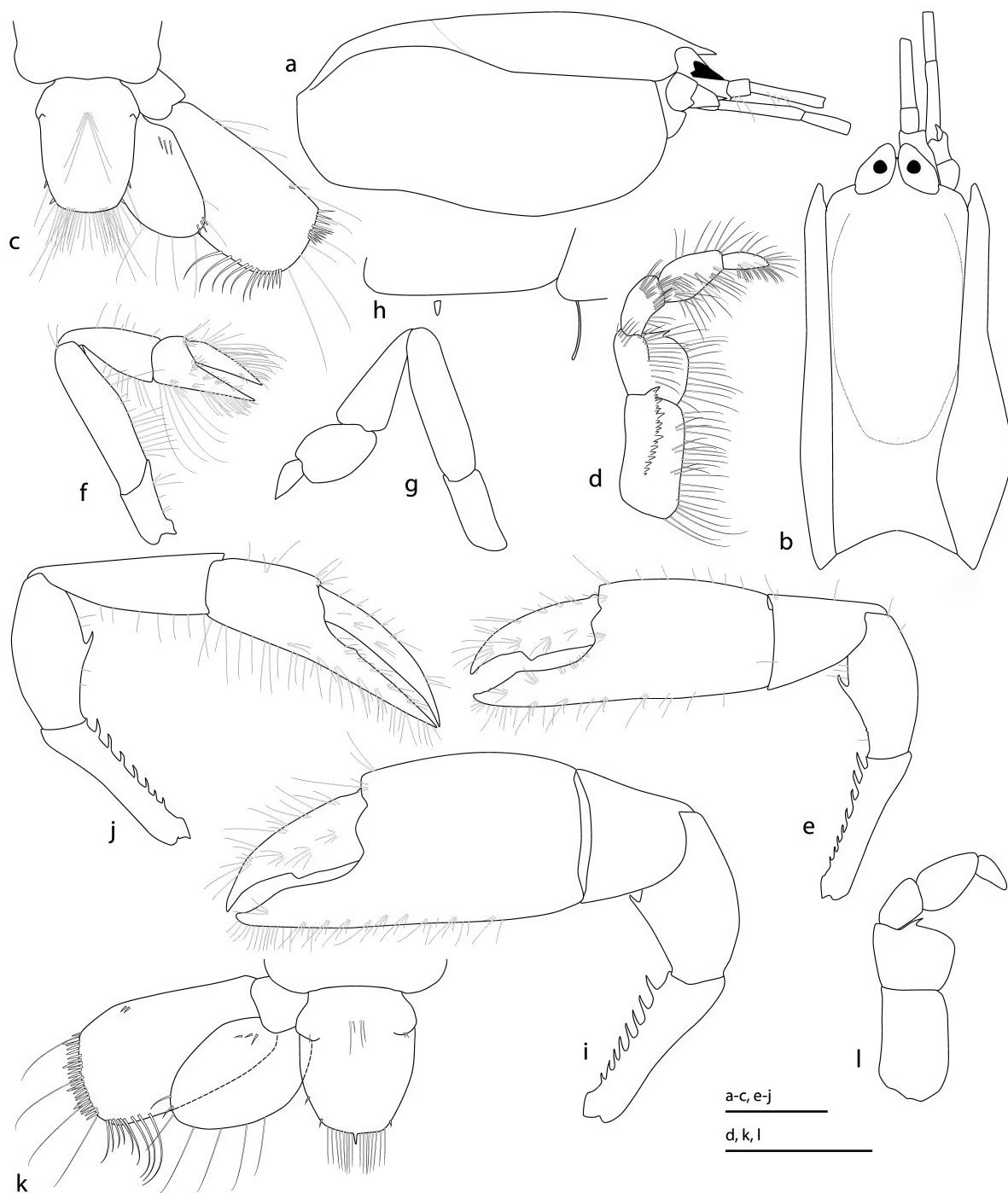


Figure 36. *Praedatrypaea propinqua* (De Man, 1905). Australia, North West Shelf. NMV J53452, female (with Bopyridae in right branchial cavity), 3.6 mm: a, b, carapace, eyestalks, antennular, antennal peduncles (lateral, dorsal views); c, telson, right uropod; d, maxilliped 3; e, major cheliped (right, mesial view); f, g, pereopods 2, 3. NMV J71760, male, 4.0 mm: h, right pleomeres 1, 2 lower margins, pleopods 1, 2 (lateral view in situ). NMV J53451, female, 3.8 mm: i, major cheliped (right, mesial view); j, minor cheliped (left, mesial view). NMV J22661, female, 2.8 mm: k, telson, left uropod. NMV J22660, female, 2.8 mm: l, maxilliped 3. Scale bars = 1 mm.

**Remarks.** Poore et al. (2019) listed six species of *Pugnatrypaea* of which four have been transferred to *Praedatrypaea* above. *Pugnatrypaea pugnatrix* (De Man, 1905) was one of two species in Robles et al.'s (2020) phylogram, the other from the Gulf of Mexico has since been described as *P. emanata* Felder and Robles, 2020. The telson of both species has a deep notch with a median spine on the posterior margin and two pairs of spiniform setae near the posterolateral curvature, long facial spiniform setae on the uropodal endopod, and a single proximal tooth on the lower margin of the merus of the major cheliped.

These features are shared with *P. iranica* (Sepahvand, Momtazi and Tudge, 2015) from the Persian Gulf, bringing the number of species to three. The spines on the eyestalks of *P. iranica* bear an uncanny resemblance to those of *Aqaballianassa thorsoni* (Sakai, 2005), also from the Persian Gulf.

In the light of this rearrangement, the diagnosis of the genus has been updated above. Liu's (2022) key to species is superseded.

### ***Pugnatrypaea pugnatrix* (De Man, 1905)**

*Callianassa pugnatrix* De Man, 1905: 611–612.—Sakai, 1999: 51–52.—Tudge et al., 2000: 143.—Sakai, 2005: 101.

*Callianassa (Cheramus) pugnatrix*.—De Man, 1928b: 27, 93, 99, 138, 151–155, pls 15, 16 fig. 23.

*Trypaea pugnatrix*.—Sakai, 2011: 406.

*Pugnatrypaea pugnatrix*.—Poore et al., 2019: 139, 143.—Robles et al., 2020: figs 1, 3, 6.

**Material examined by P.C. Dworschak.** **Philippines**, Sulu Sea, 08° 52' N, 123° 37' E, 583–569 m (MNHN stn PANGLAO 2005 CP 2358), NMCR 49803 (male, 4.8 mm).

**Distribution.** Western Coral Triangle (Philippines, Indonesia [type locality: Bali Sea, 330 m]); 330–569 m.

**Remarks.** The species was described from a holotype (cl. 4.2 mm) from Indonesia (07° 46' S, 114° 30.5' E) at 330 m depth (Siboga stn 5). Sakai (1999) re-examined the specimen (misinterpreting it as lectotype) at the Zoological Museum Amsterdam (now Naturalis Biodiversity Center). Figures of a second specimen, which provided tissue for Robles et al.'s (2020) analysis, were kindly made available by Peter C. Dworschak confirming features of the telson, rostrum, maxilliped 3 and major cheliped.

### ***Rayllianassa* Komai and Tachikawa, 2008**

*Rayllianassa* Komai and Tachikawa, 2008: 42–43.—Komai et al., 2014a: 550–551.—Poore et al., 2019: 98, 143.—Robles et al., 2020: figs 1, 3, 6.—Poore and Ahyong, 2023: 213.

**Diagnosis.** Hermaphrodite. Rostrum obsolete or obtusely triangular, flat, not reaching cornea. Cervical groove deeply incised dorsally. Eyestalk distal lobes obliquely truncated, apices diverging. Antennular peduncle exceeding antennal peduncle by quarter to half length of article 3. Antennal scaphocerite simple, longer than wide, acute. Maxilliped 3 ischium-merus as wide as long or almost so; merus wider at ischium-merus suture than long; dactylus tapering, with scattered setae over upper margin, dense brush of short setae distally on lower margin. Major cheliped merus lower margin straight or widest at midpoint, with

or without denticles. Minor cheliped half to two thirds width of major cheliped, both swollen; carpus upper margin shorter than propodus. Uropodal endopod ovoid, longer than wide, anterior margin straight, posterodistal margin evenly convex, usually with 2 facial spiniform setae on rib. Uropodal exopod about as long as wide, posterodistal margin with row of 6–8 long blade-like setae proximal to long setae on distal margin. Telson as long as or longer than wide, tapering from near base; posterior margin slightly concave, sometimes with medial spine.

**Remarks.** *Rayllianassa* was erected for *Callianassa amboinensis* De Man, 1888 by Komai and Tachikawa (2008). Komai et al. (2014b) later broadened the diagnosis to include a second species, *R. rudisulcus* Komai, Fujita and Maenosono, 2014, but Poore et al. (2019) showed this to belong to another genus, *Rudisullianassa*. *Rayllianassa* has been diagnosed by the absence of a prominent proximal hook on the merus of the major cheliped (having at most a small tooth near the midpoint), the chelipedal carpi and propodi being swollen and the width of the minor propodus about 0.6 that of the major. The lobes on the eyestalks are truncate-oblique and the maxilliped 3 particularly broad (ischium-merus 1.5 times as long as wide) (Poore et al., 2019).

Robles et al. (2020) found substantial genetic difference between eight individuals of “*Rayllianassa amboinensis*”, four from Papua New Guinea, two from the Philippines, one from the Line Islands and another from Vanuatu (mislabelled Papua New Guinea on Robles et al. [2020: fig. 3]), including within these localities. Five of these individuals plus another from Papua New Guinea were included in a reanalysis by Qi Kou (pers. comm., 7 July 2023), leading to the conclusion that at least five species are included in this complex. Estimates of interspecific evolutionary divergence ranged from 0.040 to 0.168 for 12S sequences and 0.047 to 0.143 for 16S sequences (Table 2).

Subsequent morphological examination of the specimens contributing to these analyses revealed three species corroborated by the major clades in Robles et al.'s (2020) molecular analysis: *R. amboinensis* sensu stricto, *R. aurora* sp. nov. and *R. bifida* sp. nov., and another suggested by Kou's analysis. One individual (tissue sample ULLZ 10127 from a female NHMW 25915) is included here as *Rayllianassa* sp.

The new species differ from *R. amboinensis* in some so-called generic features, necessitating the new generic diagnosis provided above, notably in the relative lengths of the antennular and antennal peduncles, armature of the major cheliped merus and shape of the pereopod 3 propodus.

Poore et al. (2019) included five species: *R. amboinensis*, *R. bangensis* (Sakai, 2005), *R. lignicola* (Alcock and Anderson, 1899), *R. parva* (Edmondson, 1944) and *R. sahil* (Poore, 2008). Only the first is so far well known. *Rayllianassa bangensis* (Sakai, 2005) is known from a single male, cl. 3.8 mm, from 49 m in the Philippines. This record and Ngoc-Ho's (1991) record of *R. amboinensis* are the only records of males in this genus – most are females, probably hermaphrodites. While the maxilliped 3 and major cheliped are typical of *Rayllianassa*, the antennal peduncle longer than the antennular peduncle is characteristic of *Rudisullianassa*. See further comment under *R. aurora* sp. nov. below. *Rayllianassa lignicola* was described

Table 2. Kimura's 2-parameter pair-wise genetic distances of 12S rRNA (below diagonal) and 16S rRNA (above diagonal) among specimens studied. Analyses were conducted based on 397 bp 12S rRNA and 405 bp 16S rRNA sequence alignments using MEGA 11 (Tamura et al. 2021).

Species	Museum number	1	2	3	4	5	6
1 <i>R. amboinensis</i>	MNHN IU-2013-7049		0.051	0.127	0.130	0.102	0.111
2 <i>R. amboinensis</i>	MNHN IU-2013-7079	0.016		0.128	0.131	0.102	0.114
3 <i>R. aurora</i> sp. nov.	MNHN IU-2016-8124	0.152	0.159		0.002	0.140	0.143
4 <i>R. aurora</i> sp. nov.	MNHN IU-2016-8125	0.152	0.159	0.000		0.137	0.140
5 <i>Rayllianassa</i> sp.	NHMH 25915 (ULLZ-10127)	0.087	0.099	0.148	0.148		0.047
6 <i>R. huonensis</i> sp. nov.	MNHN IU-2011-6054	0.112	0.114	0.168	0.168	0.040	

from two females, tl. 11 mm, 14.8 mm, from “water-logged mangrove-twigs” at 185 fm (338 m) in the Andaman Sea. The chelipeds and relative lengths of the antennal peduncles, plus the association with wood, are evidence for placement in *Rayllianassa*. The generic placement of *C. parva* in *Rayllianassa* is doubtful. While the chelipeds and telson are *Rayllianassa*-like, the relative lengths of the antennal peduncles and maxilliped 3 are not typical. *C. sahal* Poore, 2008 is synonymised with *R. amboinensis* below.

Samadi et al. (2010) reported that “*Callianassa*” *amboinensis* is associated with deep-sea wood, having been collected in traps baited with wood sunk off New Caledonia and Vanuatu. Hoyoux (2006, 2010) studied the digestion of wood in this species from Papua New Guinea (MNHN SALOMON 2 stations). *Callianassa amboinensis* has been reported from 80 metres, scarcely the deep sea, of New Caledonia, but not specifically from wood (Ngoc-Ho, 1991). The only available material from Vanuatu has been identified here as *R. bifida* sp. nov. and that from SALOMON 2 stations as *R. aurora* sp. nov., both from samples containing wood. Komai et al. (2014) summarised the depth distribution of *R. amboinensis* as 0.5 to 183 m, and cited literature showing that the species burrows in sponges or alcyonacean soft corals and suggested that the association with deep-sea wood involves species other than *R. amboinensis*. Species of another genus easily confused with *Rayllianassa*, *Rudisullianassa rudisulcus* (Komai, Fujita and Maenosono, 2014) and *Rudisullianassa pandan* sp. nov., are also from samples containing sunken wood.

### *Rayllianassa amboinensis* (De Man, 1888)

Figures 1f, 38, 39

*Callianassa amboinensis* De Man, 1888: 480, pl. 20 fig. 4.—Zehntner, 1894: 194.—Poore and Griffin, 1979: 248, fig. 14.—Sakai, 1984: 96–99, figs 1, 2.—Sakai, 1988: 53, 57, fig. 1.—Ngoc-Ho, 1991: 283, fig. 1.—Sakai, 1999: 35, 38.—Tudge et al., 2000: 143.—Ngoc-Ho, 2005: 68, fig. 12.

*Callianassa* (*Calliactites*) *amboinensis*.—Borradaile, 1903: 545.

*Callianassa* (*Trypaea*) *amboinensis*.—De Man, 1928a: 27, 93, 107, 165, pl. 18 fig. 28.

*Callianassa ngochoae* Sakai, 1999: 36, 49.—Komai et al., 2014: 553–554 (synonymy with *C. amboinensis*).—Poore et al., 2019: 98, 139, 146 (genus incertae sedis).

*Callianassa sahal* Poore, 2008: 172–174, fig. 5. **Syn. nov.**

*Callianassa* sp. MoV 4964.—Poore et al., 2008: 92.

*Notiax amboinensis*.—Sakai, 2011: 382.

*Notiax ngochoae*.—Sakai, 2011: 384–385.

*Rayllianassa amboinensis*.—Komai and Tachikawa, 2008: 43–47, figs 13–15 (Ogasawara Is).—Komai et al., 2014a: 551–554, figs 1, 2.—Poore et al., 2019: 136, 143.

*Rayllianassa* cf. *amboinensis*.—Robles et al., 2020: figs 1, 3, 6 (part).

*Trypaea sahal*.—Sakai, 2011: 407–408.

*Rayllianassa sahal*.—Poore et al., 2019: 140, 143.

**Material examined.** **Mariana Islands.** Guam I., Hospital Point, 13.502084° N, 144.768206° W, 93–95 m, UF 13834 (female, 2.4 mm). Palmyra Atoll, N side, 5.8978° N, 162.0628° E, 0–13 m, UF 11709 (ovigerous female, 3.0 mm). **Line Islands.** Kingman Reef, NEE of Atoll, 6.4036° N, 162.3427° E, UF 11678\* (ovigerous female, 4.2 mm). **Philippines.** 12° 31' N, 120° 39' E, 92–97 m, in sponge (stn MUSORSTOM 3 117), MNHN Th-1227 (female, 4 mm). **Papua New Guinea.** Bismarck Archipelago, N side of Rara I., Seeadler Harbour, Off Lorengau Town, 2° S, 147.27° E, 3–17 m, associated with Porifera, UF 8700\* (ovigerous female, 4.3 mm). Salomon Sea. N of Normanby I., d'Entrecasteaux Archipelago, 09° 49' S, 151° 34' E, 150–180 m (MADEEP stn DW4316), MNHN IU-2014-18537 (female, 3.3 mm). Madang Province, 05° 11' S, 145° 48.4' E, 8 m, in dead corals (PAPUA NIUGINI stn PB11), MNHN IU-2013-7058\* (female, 4.0 mm); MNHN IU-2013-325 (ovigerous female, 6.5 mm); 05° 10.8' S, 145° 49.8' E, 22 m (PAPUA NIUGINI stn PR10), MNHN IU-2013-7049\*# (ovigerous female, 4.1 mm); 05° 15.9' S, 145° 47.1' E, 10 m (PAPUA NIUGINI stn PB37), MNHN IU-2013-7079\*# (ovigerous female, 5.2 mm). Kavieng Province, 02° 32' S, 150° 47' E, 130–144 m (KAVIENG 2014 stn DW 4499), MNHN IU-2015-989 (female, 4.4 mm). **New Caledonia.** MNHN Th-1071 (holotype of *Callianassa ngochoae*, male/immature, 2.8 mm). **Australia.** Arafura Sea (Geosciences Australia stn 2012t07/183), NMV J71761 (ovigerous female, 9.3 mm). Timor Sea, Sahul Banks, W of Mangol Shoal, 11° 40.26' S, 125° 04.84' E, 18 m, NMV J53340 (holotype of *Callianassa sahal*, ovigerous female, cl. 4.3 mm). WA, 5.4 km E of Tish Point, Rosemary I., Dampier Archipelago, 20.498° S, 116.64° E (stn DA2/84/1), NMV J53341 (2 females, 4.2, 7.8 mm). WA, off Point Cloates, 22° 50.55' S, 113° 30.40' E, 100 m, NMV J53457 (ovigerous female).

**Diagnosis.** Antennular peduncle longer than antennal peduncle. Major cheliped merus lower margin straight or convex, smooth or with small teeth; carpus oval in cross-section, upper and lower margins weakly carinate; palm upper margin weakly carinate, without tubercles and ridges on distal mesial and lateral margins at the base of fingers; dactylus straight or strongly curved, with

blade along cutting edge or with basal tooth, apex simple. Pereopod 3 propodus suboval-angular, lower margin with distinct corner between straight proximal half and concave distal half. Uropodal exopod widest near midpoint, about as long as wide.

**Distribution.** Central and Eastern Indo-Pacific (Japan, Philippines, New Caledonia, Marquesas Is., Easter I., Indonesia [type locality: Ambon], Papua New Guinea, northern Australia); 0–183 m, associated with sponges and alcyonaceans (Komai et al., 2014b).

**Remarks.** As Komai and Tachikawa (2008), who described the species in detail, and Komai et al. (2014a) noted, *R. amboinensis* has been reported from throughout the Indo-West Pacific and illustrated several times since its discovery in Ambon, Indonesia (De Man, 1928a; Poore and Griffin, 1979; Sakai, 1984, 1988; Ngoc-Ho, 2005; Komai and Tachikawa, 2008; Komai et al., 2014a). There are some discrepancies between the illustrations, indicating that more than one species may be involved, but the three new species described below and revealed by Robles et al.'s (2020) molecular analysis have not been illustrated previously.

*Rayllianassa amboinensis* is recognised by the almost circular maxilliped 3 ischium+merus, the antennal peduncle reaching near or just beyond the midpoint of article 3 of the antennular peduncle, the triangular anterodistal lobe of the eyestalk, the palm of the major cheliped lacking a carina on the upper margin and lacking teeth on its distal margins, and the asymmetry of the lower margin of the propodus of pereopod 3 (more convex proximally than distally). Komai et al. (2014b) noted that the cervical groove is incised and a dorsal oval (postrostral depression) is present (figs 39d, 40j). The genetic variability between the four individuals from Papua New Guinea and one from the Line Islands (those remaining in *R. amboinensis* after the three new species are removed) is reflected in some morphological variability (figs 39, 40). The rostrum is more prominent in some individuals than others, the telson ranges from as long as wide to longer than wide, the length:width ratio of the uropodal rami ranges widely, the merus of the major cheliped has no or few small teeth along its lower margin and is wider in some than others, the minor palm ranges from 0.6 to 0.75 times as wide as the major palm. Ovigerous females range from cl. 3.3 mm to cl. 9.3 mm, a

considerable range that may explain some of the morphological variation. For the time being it is concluded that this material represents only one species consistent with the illustrations of De Man (1928a: Ambon), Poore and Griffin (1979: NW Australia), Sakai (1988: NT, Australia), Ngoc-Ho (1991: New Caledonia), Komai and Tachikawa (2008: S Japan) and Komai et al. (2014b: S Japan). In other illustrations, Sakai (1984: N Australia) and Ngoc-Ho (2005: Marquesas), the major cheliped palm is more barrel-shaped than typical, suggesting that *R. amboinensis* represents a species complex as yet unresolved.

All authors cited above have reported only females, but all individuals (except one) checked here are in fact hermaphrodites with both male and female gonopores. Sakai (1999) noted that in the individual from New Caledonia identified as *C. amboinensis* by Ngoc-Ho (1991), the antennal peduncle article 5, the merus of the major cheliped and the telson differed from those of *C. amboinensis* and erected a new species, *C. ngochoae* Sakai, 1999. Later, Sakai (2005) returned *C. ngochoae* to synonymy with *C. amboinensis*. Later still, Sakai (2011) revived his 1999 species as what he then called “*Notiax ngochoae*”, including in its synonymy several citations of *C. amboinensis*, including De Man's (1928a) description of its holotype. Komai et al. (2014b) summarised the complicated arguments for and against the synonymy of the two species. None of these arguments noted that the antennular peduncle scarcely exceeds the antennal peduncle (shorter than is typical) (Ngoc-Ho, 1991: fig. 1a, b) but its length relative to the carapace is similar to that in other individuals. The holotype is very small (cl. 2.8 mm) with a minute pleopod 1 and two-articled pleopod 2 (confirmed by re-examination). Ngoc-Ho (1991) assumed it to be a male but it may be immature, which could explain the unusual relative size of the antennae. The maxilliped 3, eyestalks, rostrum and relative size of the chelipeds are consistent with the specimen belonging to *R. amboinensis*.

Re-examination of the holotype of *C. sahal* Poore, 2008 has shown that it does not differ substantially from *R. amboinensis* (fig. 38a–c), and it is here synonymised.

As Komai et al. (2014b) argued, and elaborated above under **Remarks** for *Rayllianassa*, *R. amboinensis* is not associated with deep-sea wood, but has been found burrowing in sponges or alcyonacean soft corals between 0.5 and 183 m.



Figure 37. *Rayllianassa* spp. a, *R. aurora* sp. nov., Philippines, MNHN IU-2016-8126, ovigerous female, 4.4 mm; b, *Rayllianassa* sp. Philippines, NHMW 25915, ovigerous female, 4.3 mm. (colour photographs by T.-Y. Chan).



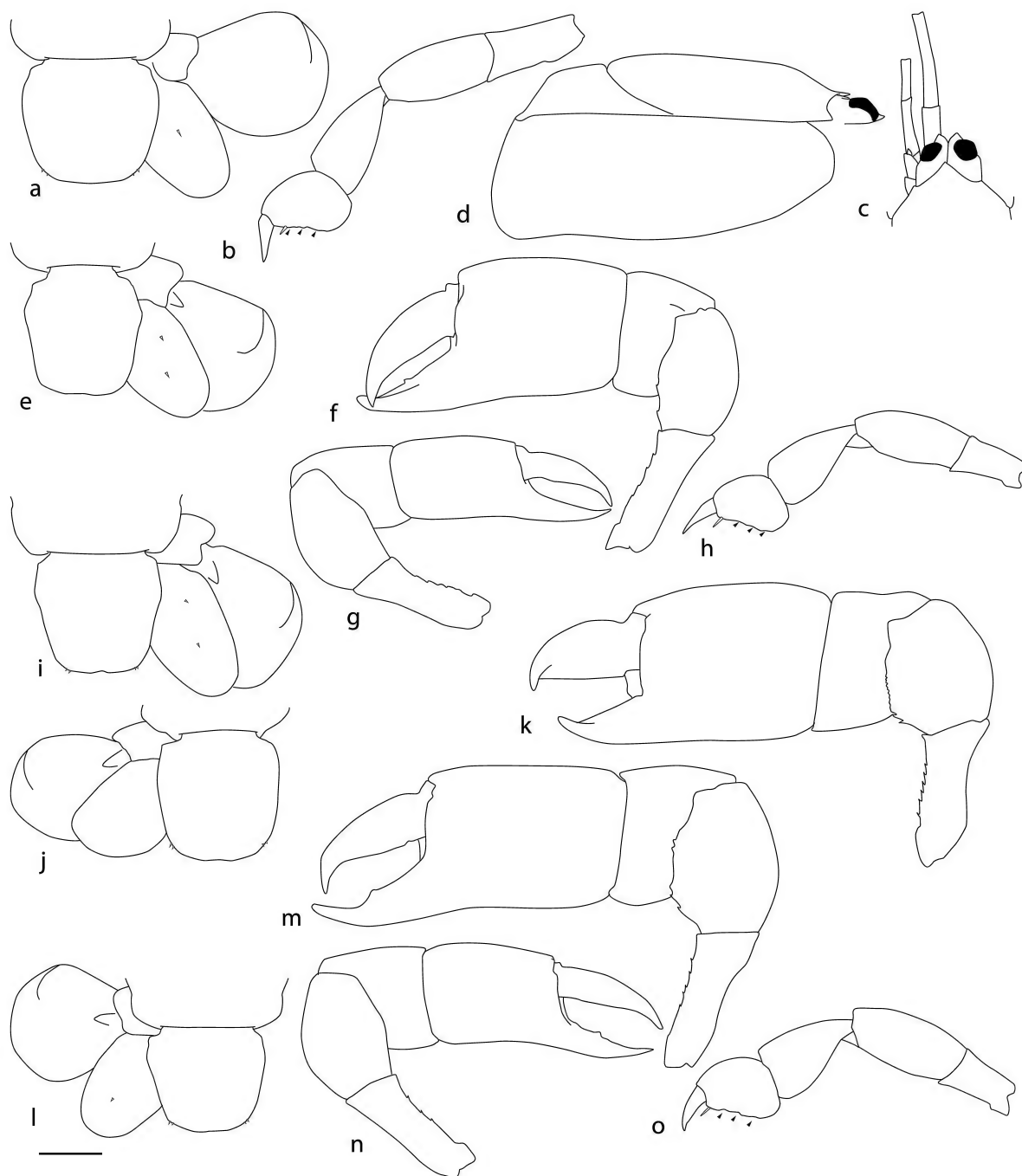


Figure 38. *Rayllianassa amboinensis* (De Man, 1888). a–d, Timor Sea, NMV J53340, holotype of *C. sahur*, ovigerous female, cl. 4.3 mm. e–h, Papua New Guinea, UF 8700, ovigerous female, 4.3 mm. i, Papua New Guinea, MNHN IU-2013-7079, ovigerous female, 5.2 mm. j, k, Papua New Guinea, MNHN IU-2013-7058, female, 4.0 mm. l–o, Line Is, UF 11678, ovigerous female, 4.2 mm. a, e, i, j, l, telson, uropod; b, h, o, pereopod 3 (arrows show gaps in marginal setae); c, anterior carapace, eyestalks, antennular, antennal peduncles; d, carapace, eyestalk (lateral); f, k, m, major cheliped (mesial); g, n, minor cheliped (mesial). Scale bar = 1 mm.

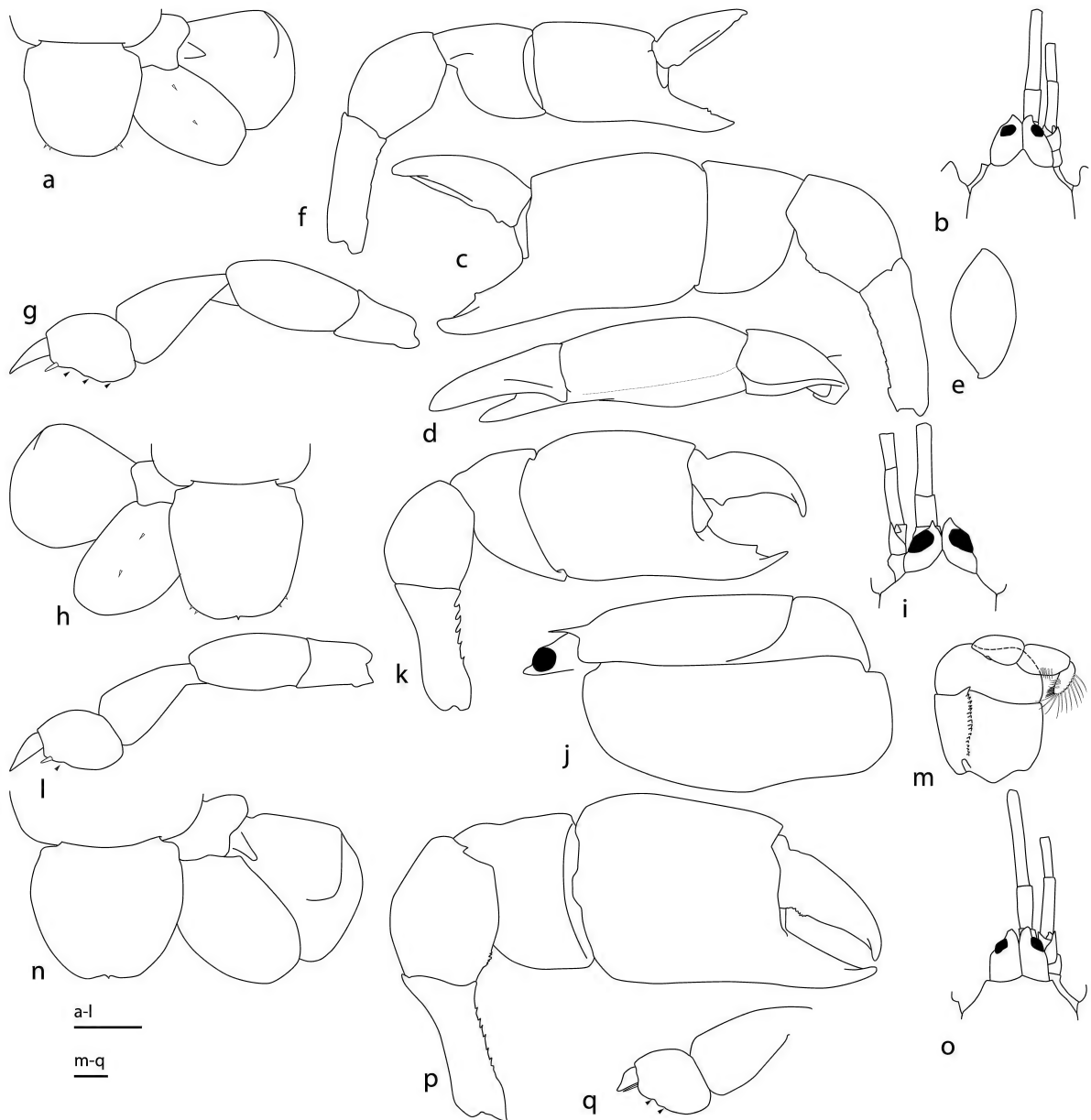


Figure 39. *Rayllianassa amboinensis* (De Man, 1888). a–g, Papua New Guinea, MNHN IU-2013-7049, ovigerous female, 4.1 mm; h–m, Papua New Guinea, MNHN IU-2015-989, female, 4.4 mm; n–q, Arafura Sea, NMV J71761, ovigerous female, 9.3 mm (Note scale). a, h, n, telson, uropod; b, i, o, anterior carapace, eyestalks, antennular, antennal peduncles; c, k, p, major cheliped (mesial); d, major cheliped, carpus–dactylus (upper); e, major cheliped carpus (cross-section, mesial face left); f, minor cheliped (mesial); g, l, q, pereopod 3 (arrows show gaps in marginal setae); j, carapace, eyestalk (lateral); m, maxilliped 3. Scale bars = 1 mm.

***Rayllianassa aurora* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:31B5E2A2-ED53-4D67-95DD-A1EB669EEFA1>

Figures 37a, 40, 41

*Callianassa amboinensis*.—Hoyoux, 2006: 33.—Samadi et al., 2010: 462.

*Rayllianassa* cf. *amboinensis*.—Robles et al., 2020: figs 1, 3, 6 (part from Philippines).

**Material examined.** Holotype. **Philippines.** Luzon, Lamon Bay, 14° 27' N, 121° 47' E, 300 m (AURORA 2007 stn CP2720), MNHN IU-2016-8126 (ovigerous female, 4.4 mm). Paratypes, collected with holotype. MNHN IU-2013-7135 (16 females, 1.8–4.9 mm), NMV J71762 (3 ovigerous females, 4.9 mm); MNHN IU-2013-7136 (ovigerous female, 4.0 mm), MNHN IU-2016-8124\*# (ovigerous female, 5.1 mm); MNHN IU-2016-8125# (ovigerous female, 4.4 mm). Philippines. Luzon, Lamon Bay, 14° 29' N, 121° 43' E, 311–361 m (AURORA 2007 stn CP2717), MNHN IU-2013-7139 (9 females, 1.6–3.4 mm). Other material examined by P.C. Dworschak. **Philippines.** Luzon, Lamon Bay, MNHN AURORA 2007 stations: 14° 29' N, 121° 48' E, 216–220 m (stn CP2718), NHMW 26465 (ovigerous female, 5.3 mm); 14° 26' N, 121° 48' E, 160–155 m (stn CP2719), NHMW 26467 (7 females); 14° 27' N, 121° 47' E, 300 m (stn CP2720), NHMW 26466 (ovigerous female), NMCR 50819 (female); 14° 23' N, 121° 50' E, 156–147 m (stn CC2723), NMCR 50820 (female), NMCR 50821 (ovigerous female); Baler Bay, 15° 54.2' N, 121° 54.2' E, 100 m (stn CP2760), NMCR 50808 (ovigerous female), NMCR 50822 (ovigerous female), NMCR 50823 (ovigerous female).

**Diagnosis.** Antennular peduncle little shorter than antennal peduncle. Major cheliped merus with tooth or small teeth along lower margin; carpus oval in cross-section, margins weakly carinate; palm upper margin with obsolete carina, with tubercles and ridges on distal mesial and lateral margins at the base of fingers; dactylus with blade along cutting edge, apex simple. Pereopod 3 propodus oval, not wider proximally. Uropodal exopod widest near midpoint, 1.8 times as long as wide.

**Description of holotype.** Hermaphrodite. Rostrum obsolete, situated below level of dorsal carapace. Carapace dorsally convex in lateral view, as long as pleomeres 1–2 combined; orbital margin almost transverse, with pair of uncalcified areas laterally; anterolateral angle blunt; subanterolateral margin almost horizontal; anterior margin of branchiostegite convex; cervical groove deeply incised, across 0.8 length of carapace, reaching linea thalassinica. Pleomere 1 tergite with shallow transverse groove. Pleomere 2 twice as long as pleomere 1. Pleomere 6 about as long as wide.

Eyestalk 1.2 times as long as wide, with dorsal face depressed anteriorly, with sharp ventrolateral margin, anterolateral margin oblique, anteromedial angle angular in dorsal view, displaced laterally, reaching distal margin of antennular peduncle article 1. Cornea densely pigmented, occupying anterolateral margin of eyestalk.

Antennular peduncle little shorter than antennal peduncle; article 1 visible in dorsal view; article 3 1.2 times as long as

articles 1 and 2 combined; article 2 with dense longitudinal ventral row of long setae; article 3 with well-spaced ventral setae. Antennal peduncle article 5 about as long as article 4; scaphocerite triangular.

Maxilliped 3 ischium dilating distally, 1.2 times as long as wide, crista dentata consisting of about 20 small, well-spaced irregular teeth; merus 0.7 times as long as ischium measured along outer margin, about 1.6 times as wide as long, as wide as ischium, with mesiodistal margin produced as weak lobe beyond base of carpus; carpus little shorter than merus outer margin; propodus ovoid-tapering, 1.5 times as long as wide; dactylus ovoid, as long as propodus.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped massive, carpus-palm upper margin 1.2 carapace length. Ischium expanding distally, upper margin concave, unarmed; lower margin with row of 7 similar small teeth. Merus as long as ischium, 1.5 times as long as wide (tooth excluded), ovate; upper margin convex, unarmed; lower margin with tooth near midpoint, another minor tooth more distal. Carpus 0.65 as long as wide; upper margin rounded; lower margin weakly carinate, with shallow mesial depression parallel to margin. Propodus upper margin 2.1 times as long as carpus; palm almost parallel-sided, 1.2 times as long as wide; upper margin obscurely angled along mesial length; lateral surface smooth, convex; distolateral margin of palm oblique, with tubercle near base of finger; mesial surface convex, distomesial margin oblique, set back from distolateral margin, with prominent oblique crenellate ridge; lower margin carinate, with row of setae extending onto fixed finger; fixed finger 0.5 length of palm, triangular; cutting edge lateral, a crenellate blade. Dactylus as long as fixed finger, hooked distally, with acute tip; upper margin double-ridged, with tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge with triangular tooth one third along, blade-like over distal half.

Minor cheliped carpus-palm upper margin 0.7 carapace length. Ischium upper margin smooth, lower margin with row of 3 teeth. Merus about as long as ischium; lower margin with obtuse angle at midpoint. Carpus wider distally, 0.8 length of merus, as long as wide, upper and lower margins rounded. Palm swollen, 1.4 times as long as wide; upper margin convex, with obscure mesial angle; lower margin carinate, with row of long setae extending onto fixed finger; distomesial margin with small tubercle at base of fixed finger; distolateral margin with crenellate oblique ridge at base of finger. Fixed finger, 0.7 length of palm, cutting edge lateral, with small irregular tubercles. Dactylus malformed in holotype, tapering, as long as fixed finger in paratypes.

Pereopod 2 merus lower margin slightly sinusoidal, 2.3 times as long as wide; carpus about 1.6 times as long as wide; chela subtriangular; palm about 1.3 times as wide as upper margin; dactylus 1.5 times as long as palm upper margin. Pereopod 3 merus 2.8 times as long as wide; carpus subtriangular, 1.8 times as long as wide; propodus oval, upper margin 1.2 times greatest width, lower margin evenly convex, without proximal heel, marginal setae with 3 clear gaps along distal half, with 1 slender spiniform seta subdistally; dactylus about 0.6 length of propodus upper margin. Pereopod 4 coxa flattened ventrally, distal articles linear. Pereopod 5 chelate.

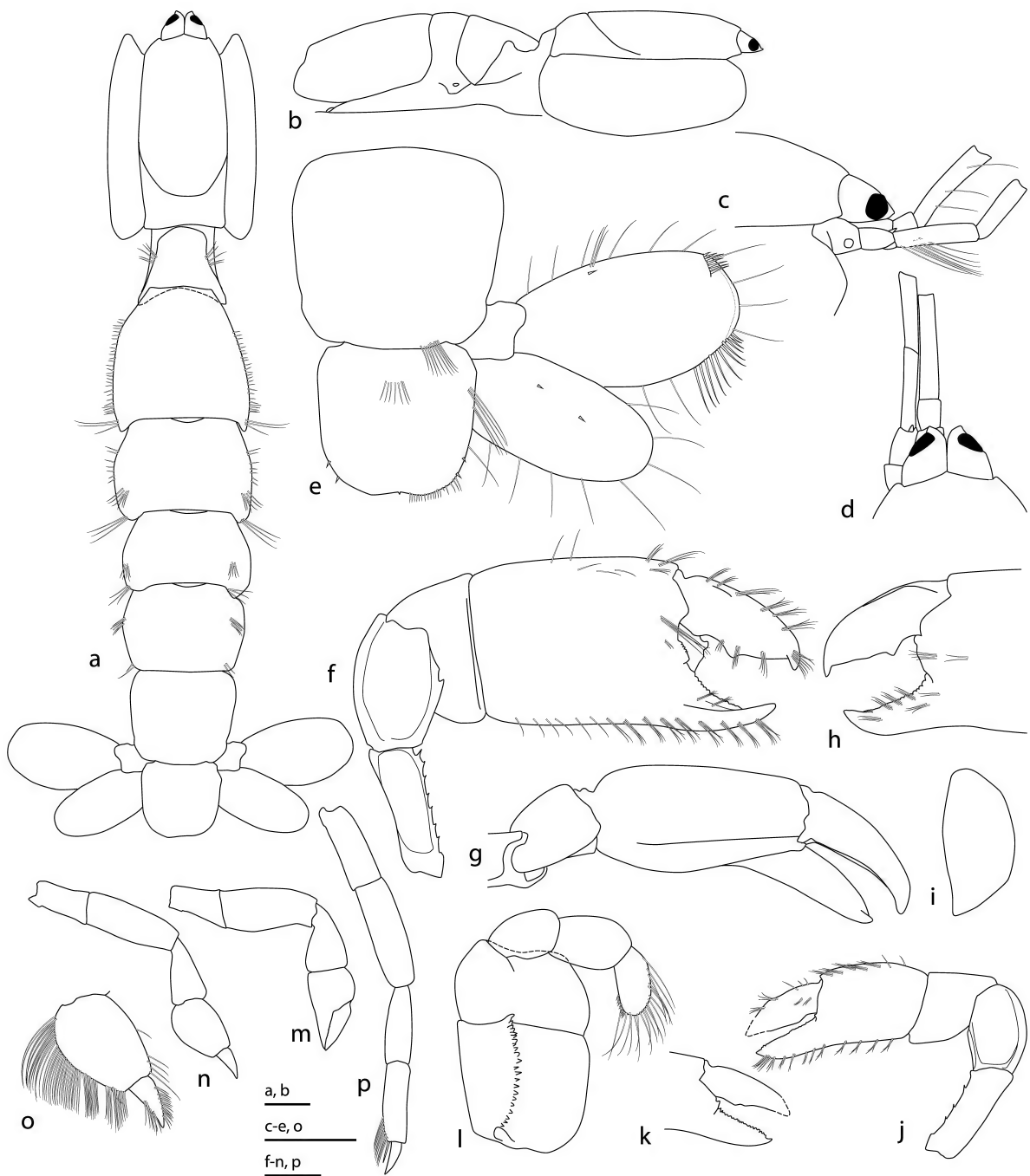


Figure 40. *Rayllianassa aurora* sp. nov. Philippines. MNHN IU-2016-8126, holotype ovigerous female, 4.4 mm: a, eyestalks, carapace, pleon, uropods, telson (dorsal); b, eyestalk, carapace, pleomeres 1, 2 (lateral); c, d, eyestalk, antennular, antennal peduncles, anterior carapace (lateral, dorsal); e, pleomere 6, right uropod, telson; f, major cheliped (left, mesial); g, major cheliped, carpus–dactylus (upper view); h, major cheliped distal palm, fingers (lateral); i, major cheliped (cross-section, upper topmost, mesial left); j, minor cheliped (right, mesial); k, minor cheliped distal palm, fingers (lateral); l, maxilliped 3; m, n, pereopods 2, 3; o, pereopod 3 propodus, dactylus; p, pereopod 4. Scale bars = 1 mm.

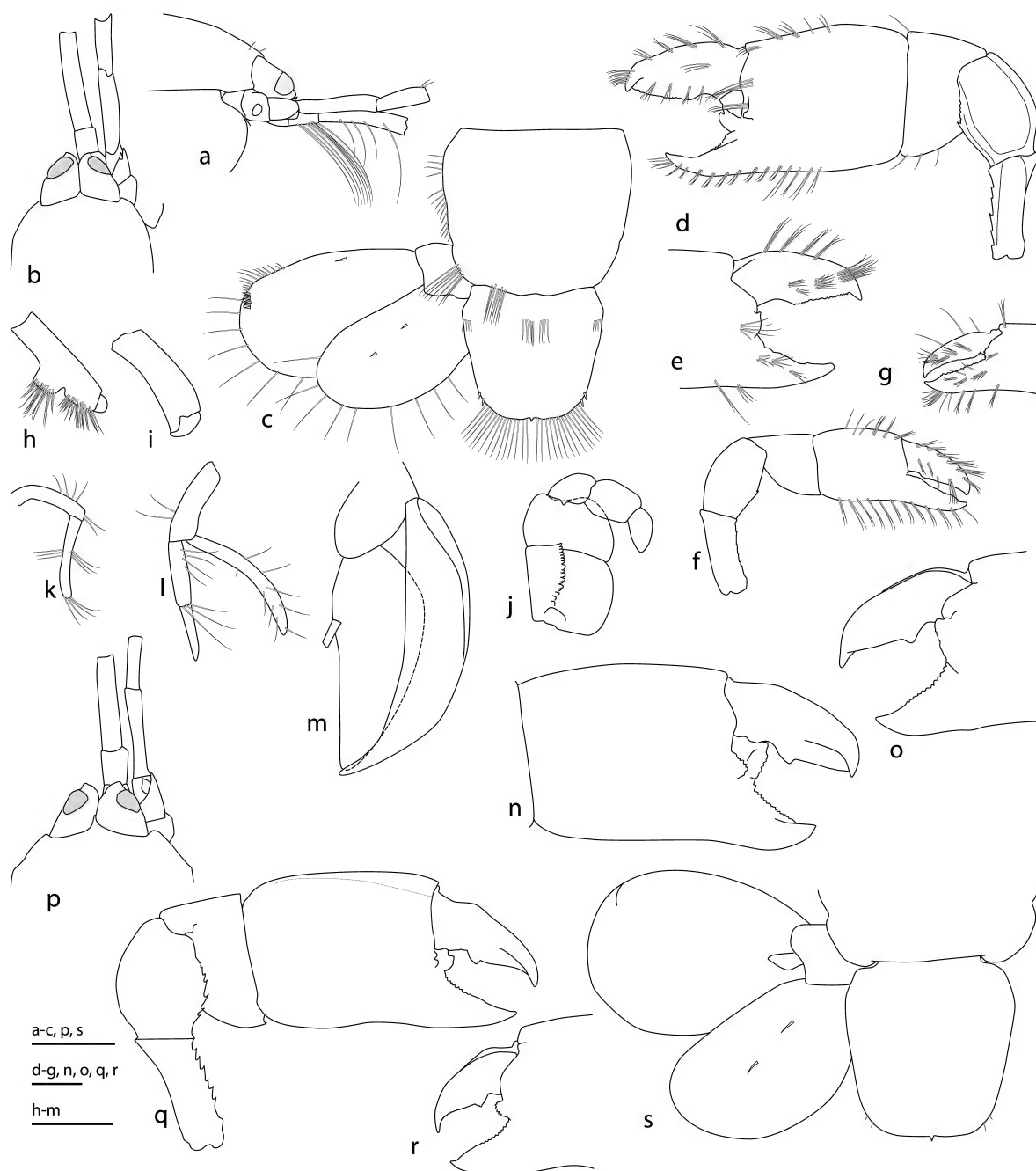


Figure 41. *Rayllianassa aurora* sp. nov. Philippines. MNHN IU-2016-8125, paratype ovigerous female, 4.4 mm: a, b, eyestalk, antennular, antennal peduncles, anterior carapace (lateral, dorsal); c, pleomere 6, left uropod, telson; d, major cheliped (left, mesial); e, major cheliped distal palm, fingers (lateral); f, minor cheliped (right, mesial); g, minor cheliped distal palm, fingers (lateral); h, right pereopod 5 propodus, dactylus (atypical); i, left pereopod 5 propodus, dactylus; j, maxilliped 3. MNHN IU-2016-8126, holotype ovigerous female, 4.4 mm: k-m, pleopods 1-3. MNHN IU-2016-8124, paratype ovigerous female, 5.1 mm: n, major cheliped palm, fingers (left, mesial); o, major cheliped distal palm, fingers (lateral). Papua New Guinea, MNHN IU-2017-1358, ovigerous female, 5.4 mm: p, anterior carapace, eyestalks, antennular, antennal peduncles (dorsal); q, major cheliped palm, fingers (left, mesial); r, major cheliped distal palm, fingers (lateral). MNHN IU-2016-8143, ovigerous female, 5.4 mm: s, left uropod, telson. Scale bars = 1 mm.

Pleopod 1 of 2 articles at right angles; ramus about as long as peduncle; setose. Pleopod 2 biramous; endopod slightly shorter than exopod. Pleopods 3–5 biramous, endopod 2.4 times as long as wide; appendix interna slender, rod-like, projecting well beyond mesial margin of endopod.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval, widest near midpoint, about twice as long as wide; upper surface with 2 spiniform setae on dorsal rib; anterior margin almost straight; distal margin evenly convex, with fringe of setae; posterior margin setose. Exopod widest near midpoint, 1.8 times as long as wide, exceeding endopod by one quarter its length; anterior margin convex; all margins with numerous slender setae, with about 12 blade-like setae on posterior margin indistinguishably merged with distal margin; dorsal plate apparent on distal margin as row of about 7 stiff setae merging anteriorly with similar setae on anterior margin.

Telson as wide as long, broadest at anterior fifth, narrowing posteriorly to broadly rounded posterolateral corners; posterolateral corners each with 2 spiniform setae; posterior margin medially excavate, with minute median tooth; dorsal surface with few medial setae.

**Variation.** The rostrum of the types from the Philippines is shorter (figs 40d, 41b) than that of the two specimens from Papua New Guinea (fig. 41p). The armature on the distomesial margin of the propodus of the major cheliped varies from a crenellate ridge to rugose tubercle (cf. figs 40f, 41d, n, q); the distolateral margin appears to be always produced, often with a tubercle uppermost on the distal ridge (figs 40h, 41e, o, r). The uropodal endopod is about twice as wide as long in the holotype (fig. 40e) but is relatively wider in the illustrated paratype (fig. 41c) and the example from Papua New Guinea (fig. 40s); all appear to have two spiniform setae along the rib. The pereopod 5 propodus of the illustrated paratype has a secondary bunch of setae on a secondary “thumb” (fig. 41h).

**Etymology.** From AURORA, the name of the MNHN cruise during which this material was collected, so named after the Aurora Memorial National Park on the eastern coast of Luzon, the Philippines (noun in apposition).

**Distribution.** Western and Eastern Coral Triangle (Philippines, Papua New Guinea); 94–361 m.

**Remarks.** *Rayllianassa aurora* differs from *R. amboinensis* in: (1) having an oval propodus on pereopod 3 (not wider proximally as in *R. amboinensis*); (2) the peduncle of the antennule being shorter than that of the antenna (the antennular peduncle is longer in *R. amboinensis*); (3) a narrower uropodal exopod; and (4) tubercles and ridges on the distal mesial and lateral margins of the palm of the chelipeds at the base of the fingers. Robles et al. (2020) recorded one of the paratypes as *Rayllianassa cf. amboinensis*.

The major cheliped of *R. aurora* is similar to that of *R. bangensis* Sakai, 2005, also from the Philippines. Sakai (2005) figured the antennal peduncle as longer than the antennular peduncle (as in *Rudisullianassa*) and the telson much longer than in *R. aurora*.

Much of the material recorded from the Philippines at the AURORA 2007 stations was associated with wood.

### *Rayllianassa bifida* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:DF11C5CD-E6EF-4C09-9952-44505A84A984>

Figures 1g, 42, 43

*Rayllianassa cf. amboinensis*.—Robles et al., 2020: figs 1, 3, 6 (part).

**Material examined.** Holotype. **Vanuatu.** NW of Malo I., 15° 38' S, 167° 04' E, 114–132 m (Santo 2006 stn AT05), MNHN IU-2013-7137\* (female, 4.4 mm). Paratype, collected with holotype, MNHN IU-2017-1357 (ovigerous female, 4.7 mm).

**Diagnosis.** Antennular peduncle about as long as antennal peduncle. Major cheliped merus with large proximal bifid tooth on lower margin; carpus upper and lower margins carinate, directed mesially to form parallel depressions above and below swollen mesial face; palm upper margin with narrow rounded keel, without tubercles and ridges on distal mesial and lateral margins at the base of fingers; dactylus with blade along cutting edge, apex simple. Pereopod 3 propodus oval, not wider proximally. Uropodal exopod widest near midpoint, 1.8 times as long as wide.

**Description of holotype.** Hermaphrodite. Rostrum broadly triangular, apically depressed, situated below level of dorsal carapace, one quarter length of eyestalks. Carapace dorsally convex in lateral view, as long as pleomeres 1–2 combined; orbital margin almost transverse; anterolateral angle blunt; subanterolateral margin almost horizontal; anterior margin of branchiostegite convex; cervical groove deeply incised, across 0.8 length of carapace, reaching linea thalassinica. Thoracic sternite 7 wider than long, posterior margin deeply incised between pair of lobes. Pleomere 1 tergite with shallow transverse groove. Pleomere 2 twice as long as pleomere 1. Pleomere 6 about as long as wide.

Eyestalk little longer than wide, with dorsal face close to rostrum, with sharp ventrolateral margin, anterolateral margin oblique, anteromedial angle rounded in dorsal view, not reaching distal margin of antennular peduncle article 1. Cornea densely pigmented, occupying anterolateral margin of eyestalk.

Antennular peduncle about as long as antennal peduncle (neither individual with both); article 1 visible in dorsal view; article 3 about as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 0.75 length of article 4; scaphocerite minute, triangular (paratype).

Maxilliped 3 ischium dilating distally, 1.2 times as long as wide, crista dentata consisting of row of about 20 small, well-spaced irregular teeth; merus about half as long as ischium measured along outer margin, about 1.4 times as wide as long, wider than ischium, with mesiodistal margin produced as convex lobe beyond base of carpus; carpus about as long as merus outer margin; propodus ovoid-tapering, 1.6 times as long as wide; dactylus digitiform, 0.8 times length of propodus.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped massive, carpus-palm upper margin 1.5 times carapace length. Ischium expanding distally, upper margin almost straight, unarmed; lower margin with row of 7 similar spines. Merus as long as ischium, 1.8 times as long as wide (tooth excluded),

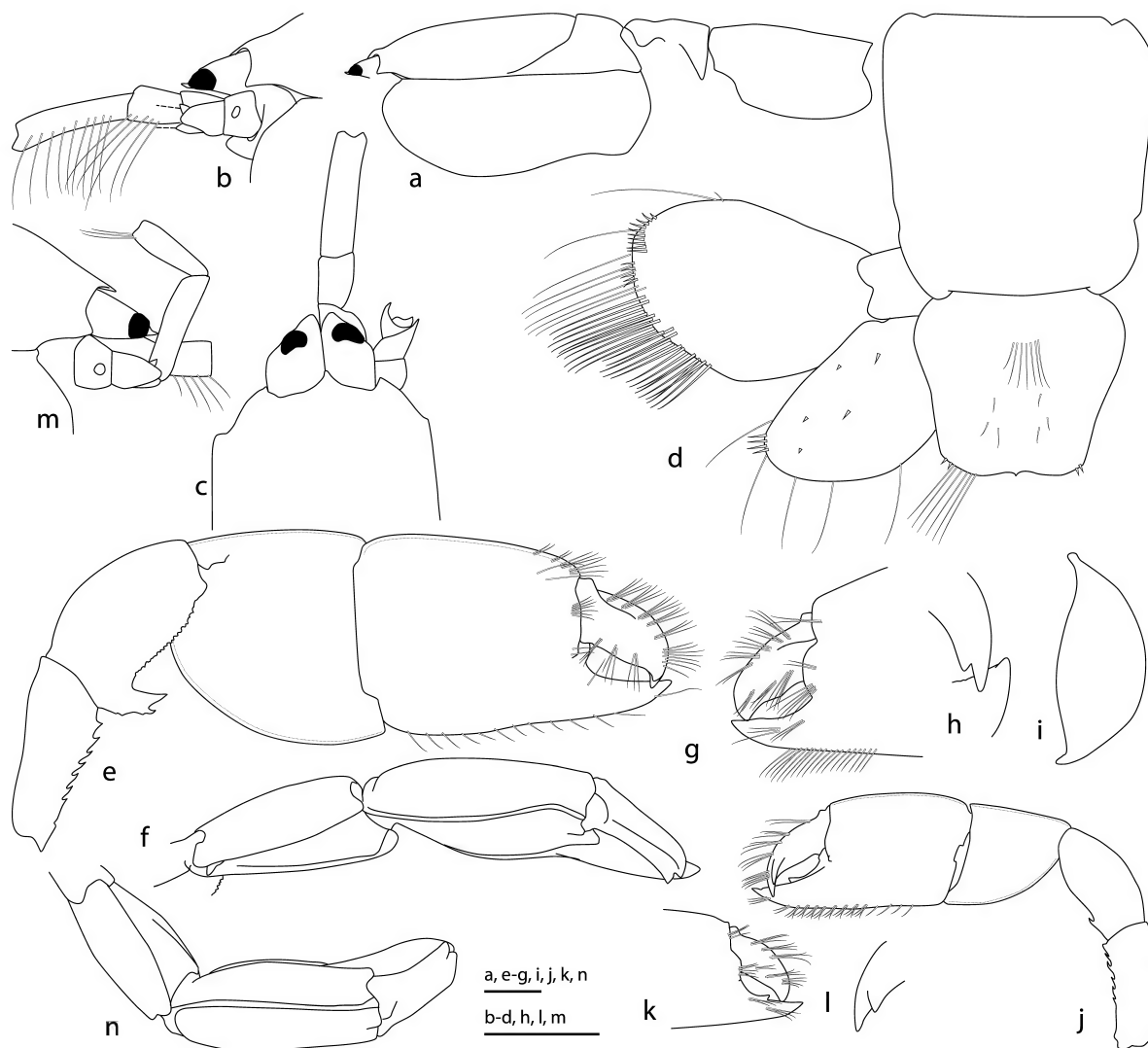


Figure 42. *Rayllianassa bifida* sp. nov. Vanuatu. MNHN IU-2013-7137, holotype female, 4.4 mm: a, carapace, pleomeres 1, 2 tergites, eyestalk; b, c, carapace, eyestalks, antennular peduncle, antennal peduncle articles 1–3 (lateral, dorsal); d, pleomere 6, telson, left uropod; e, major cheliped (left, mesial); f, major cheliped, carpus–dactylus (upper view); g, major cheliped fingers (lateral); h, major cheliped finger tips (apical view); i, major cheliped carpus cross-section (upper margin topmost, inner face left); j, minor cheliped (right, mesial); k, minor cheliped fingers (lateral); l, minor cheliped dactylus (apical view). MNHN IU-2017-1357, paratype ovigerous female, 4.7 mm: m, anterior carapace, eyestalk, antennular peduncle article 2, antennal peduncle; n, major cheliped, carpus–dactylus (upper view). Scale bars = 1 mm.

ovate; upper margin convex, unarmed; lower margin with subproximal bicuspid spine, with small blunt teeth over distal three quarters. Carpus 0.85 as long as wide; upper and lower margins carinate, directed mesially to form parallel depressions above and below swollen mesial face. Propodus upper margin 1.2 times as long as carpus; palm widest subproximally, as wide as carpus, tapering, as long as wide; upper margin with narrow rounded keel; lateral surface smooth, convex; mesial surface convex, with obtuse angle set back from distolateral margin;

lower margin carinate, with row of setae extending onto fixed finger; fixed finger 0.4 length of palm, distally directed; cutting edge lateral, blade-like. Dactylus as long as fixed finger, hooked distally, with acute tip and mesial accessory tooth; upper margin ridged, with tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge unarmed.

Minor cheliped carpus–palm upper margin as long as carapace length. Ischium upper margin smooth, lower margin with row of 6 teeth. Merus about as long as ischium; lower

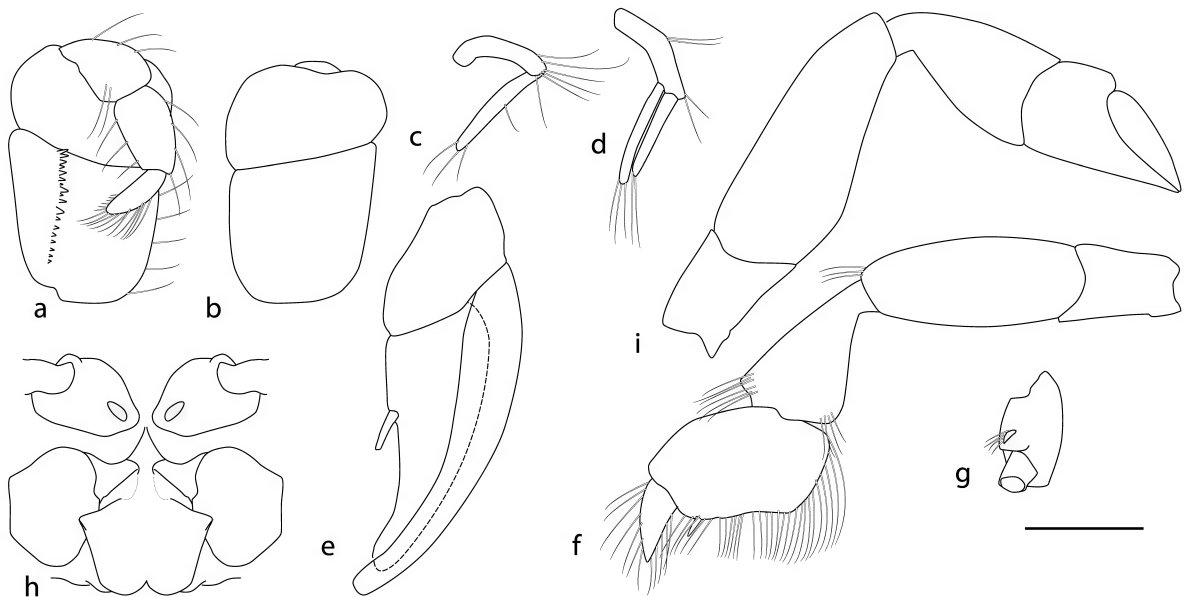


Figure 43. *Rayllianassa bifida* sp. nov. Vanuatu. MNHN IU-2013-7137, holotype female, 4.4 mm: a, b, maxilliped 3 (left, inner, outer views); c–e, pleopods 1–3; f, pereopod 3; g, pereopod 5 coxa (mesial view); h, thoracic sternite 7, pereopodal coxae 3, 4. MNHN IU-2017-1357, paratype ovigerous female, 4.7 mm: i, pereopod 2. Scale bar = 1 mm.

margin with tooth about one quarter along. Carpus wider distally, little shorter than merus, as long as wide, upper and lower margins carinate as in major cheliped. Palm slightly swollen, 1.2 times as long as wide; upper margin convex, with narrow rounded keel; lower margin carinate, with row of long setae extending onto fixed finger; mesial face with small tubercle at base of fixed finger. Fixed finger deep, triangular, half as long as palm, cutting edge lateral, with tooth at midpoint. Dactylus as long as palm, curved, with subapical mesial accessory tooth; cutting edge smooth.

Pereopod 2 merus lower margin slightly sinusoidal, 2.5 times as long as wide; carpus about 1.8 times as long as wide; chela subtriangular; palm about 1.6 times as wide as upper margin; dactylus twice as long as palm upper margin. Pereopod 3 merus 2.4 times as long as wide; carpus subtriangular, 1.7 times as long as wide; propodus suboval-angular, upper margin 1.2 times greatest width, lower margin with distinct corner between straight proximal half and concave distal half, marginal setae with 2 clear gaps along distal half, with 1 slender spiniform seta subdistally; dactylus about 0.7 length of propodus upper margin. Pereopod 4 coxa flattened ventrally, otherwise unknown. Pereopod 5 chelate.

Pleopod 1 of 2 articles at right angles; ramus 1.2 times as long as peduncle; setose. Pleopod 2 biramous; endopod slightly shorter than exopod. Pleopods 3–5 biramous, endopod 2.3 times as long as wide; appendix interna slender, rod-like, projecting well beyond mesial margin of endopod.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval-tapering, widest over proximal half, about 1.5 times as long as wide; upper surface with 2

spiniform setae on dorsal rib, 3 others more anteriorly; anterior margin almost straight; anterodistal margin with 4 short spiniform setae; distal margin convex, with fringe of setae; posterior margin setose. Exopod widest near midpoint, 1.5 times as long as wide, exceeding endopod by one quarter its length; anterior margin almost straight; all margins with numerous slender setae, with more than 20 blade-like setae on posterior margin indistinguishably merged with distal margin; dorsal plate apparent on distal margin as row of about 12 stiff setae merging anteriorly with similar setae on anterior margin.

Telson trapezoidal, 1.2 times as wide as long, broadest at anterior fifth, narrowing posteriorly; greatest width 1.4 times posterior width; posterolateral angle each with spiniform setae; posterior margin medially excavate, with median tooth; dorsal surface with few medial setae.

**Variation.** The two individuals are similar; the meral tooth on the paratype is not so obviously bicuspid as in the smaller holotype.

**Etymology.** *bifida* (Latin), describing the tips of the cheliped dactyli.

**Distribution.** Tropical Southwestern Pacific (Vanuatu); 114–132 m.

**Remarks.** *Rayllianassa bifida* is represented by MNHN IU-2013-7137, one of two individuals on the smaller primary clade in the molecular phylogram of Robles et al. (2020: fig. 3 [mislabelled PNG]).

*Rayllianassa bifida* shares with *R. amboinensis* a broad angular propodus of pereopod 3, a broad oval maxilliped 3,



prominent mesial lobes on the eyestalks, large cornea, a large major cheliped relative to the carapace, spiniform setae along the uropodal endopod ridge, and hermaphroditism. The new species differs in having a proximal tooth on the major cheliped merus (never seen in *R. amboinensis*), a feature shared with *R. huonensis* sp. nov. Whereas the upper margin of the cheliped of *R. amboinensis* has a dull ridge visible only mesially as a shadow under suitable lighting, *R. bifida* has a prominent ridge on the upper margin of the carpus and propodus (fig. 42f, n); on the carpus this ridge and the one on the lower margin are directed mesially as carinae, creating shallow mesial concavities parallel

to the margins (fig. 42i). The third article of the antennule is much shorter and thicker than that of *R. amboinensis* figured by De Man (1928a) and Komai et al. (2014a), making the antennular and antennal peduncles of similar lengths.

***Rayllianassa huonensis* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:F4FE461E-177A-4750-A156-A08643400AC9>

Figures 44, 45

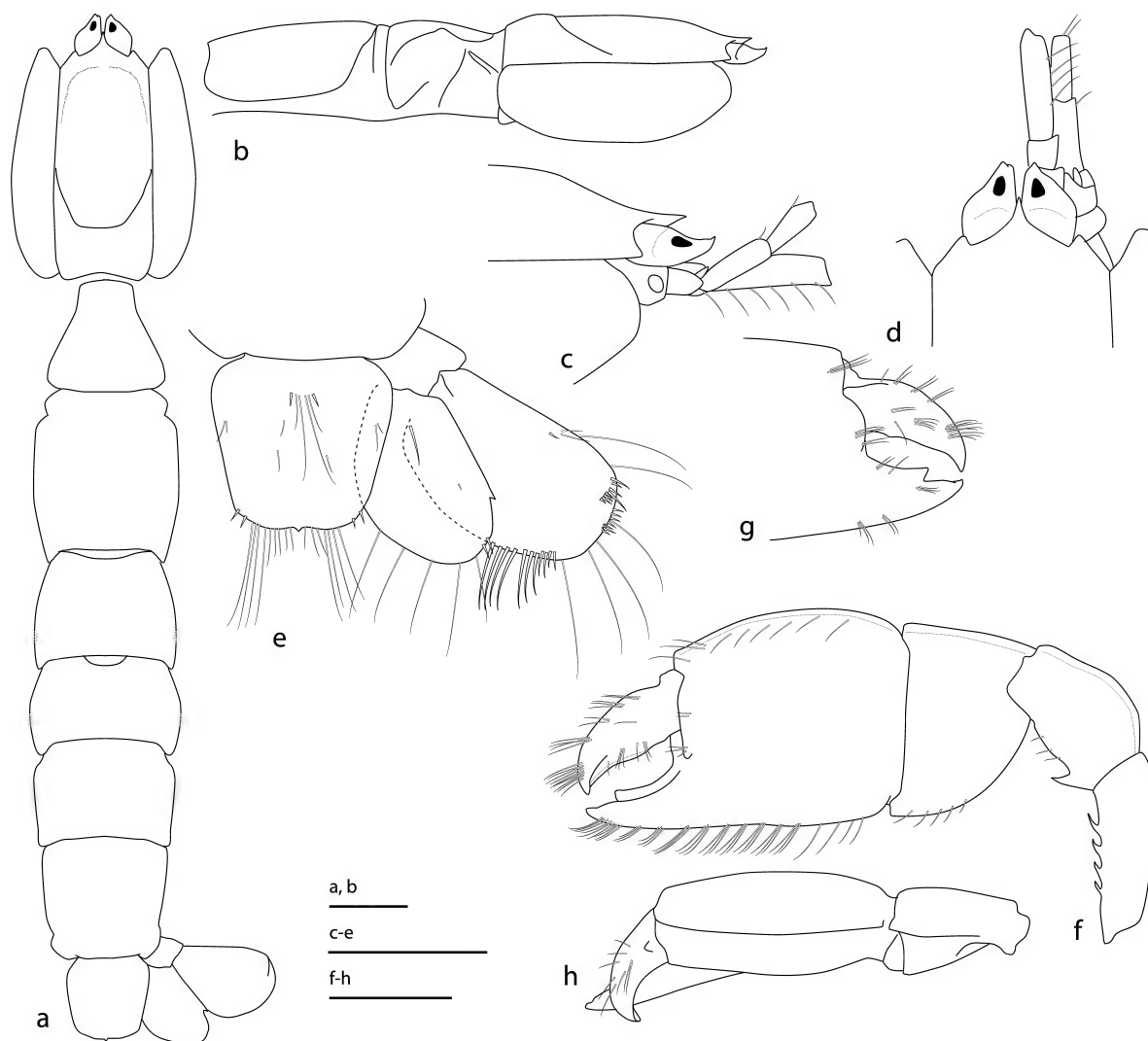


Figure 44. *Rayllianassa huonensis* sp. nov. Papua New Guinea. MNHN IU-2011-6054 (holotype ovigerous female, 3.1 mm: a, eyestalks, carapace, pleon, telson, uropod (dorsal); b, eyestalk, carapace, pleomeres 1, 2 (lateral); c, d, antennular, antennal peduncles, eyestalk, anterior carapace (lateral, dorsal); e, telson, right uropod; f, major cheliped (right, mesial); g, major cheliped distal palm, fingers (lateral); h, carpus–dactylus (upper). Scale bars = 1 mm.

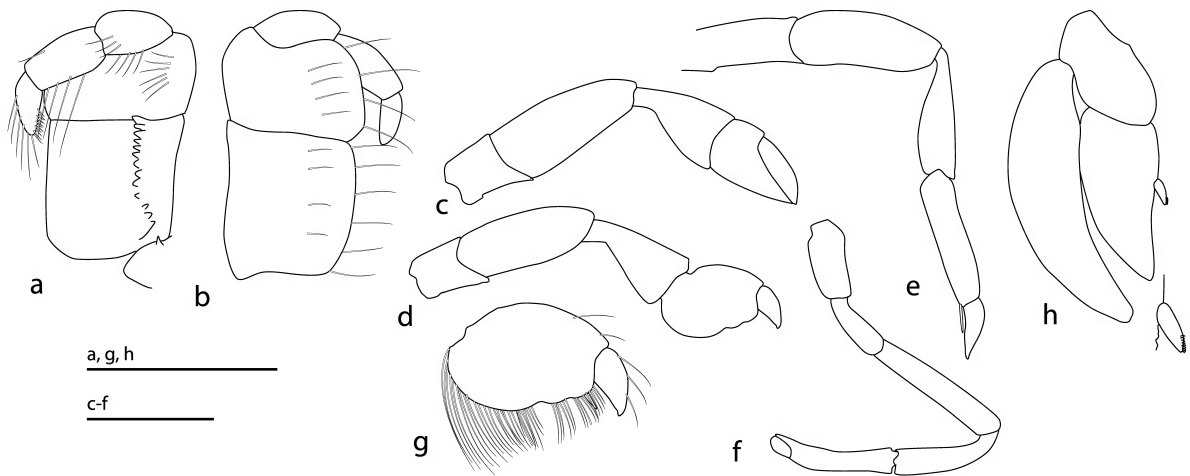


Figure 45. *Rayllianassa huonensis* sp. nov. Papua New Guinea. MNHN IU-2011-6054 (holotype ovigerous female, 3.1 mm: a, b, maxilliped 3 (mesial, lateral views); c–f, pereopods 2–5; g, pereopod 3 propodus, dactylus, h, pleopod 3 (with detail of appendix interna. Scale bars = 1 mm).

**Material examined.** Holotype. **Papua New Guinea**, Huon Gulf, SE of Lae, 07° 27' S, 147° 31' E, 462–495 m (BIOPAPUA stn CP3636), MNHN IU-2011-6054# (ovigerous female, 3.1 mm).

**Diagnosis.** Antennular peduncle about as long as antennal peduncle. Major cheliped merus with simple proximal tooth and carinate along most of lower margin; carpus and merus upper margins carinate; palm upper margin with narrow rounded keel, without tubercles and ridges on distal mesial and lateral margins at the base of fingers; dactylus with blade along cutting edge, apex simple. Pereopod 3 propodus oval, widest proximally. Uropodal exopod widest near midpoint, 1.6 times as long as wide.

**Description of holotype.** Carapace dorsally flat in lateral view, 0.8 length of pleomeres 1–2 combined; orbital margin oblique; anterolateral angle blunt; subanterolateral margin horizontal; anterior margin of branchiostegite convex; cervical groove deeply incised, across 0.8 length of carapace, almost reaching linea thalassinica. Pleomere 1 tergite without transverse groove. Pleomere 1.7 times as long as pleomere 1. Pleomere 6 about as long as wide.

Eyestalk 1.4 times as long as wide, with dorsal face close to rostrum, with sharp ventrolateral margin, anterolateral margin oblique, anteromedial angle triangular, acute in dorsal view, upturned, reaching distal margin of antennular peduncle article 1. Cornea densely pigmented, small, not filling anterior half of eyestalk.

Antennular peduncle about as long as antennal peduncle; article 1 visible in dorsal view; article 3 longer than articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of long setae. Antennal peduncle article 5 as long as article 4; scaphocerite minute, oval.

Maxilliped 3 ischium almost parallel-sided, 1.3 times as long as wide, crista dentata consisting of row of about 13 teeth, contiguous distally; merus about two thirds as long as ischium

measured along outer margin, about 1.4 times as wide as long, wider than ischium, with mesiodistal margin produced as convex lobe beyond base of carpus; carpus about as long as merus outer margin; propodus ovoid-tapering, 1.8 times as long as wide; dactylus digitiform, 0.8 length of propodus.

Major cheliped massive, carpus-palm upper margin 0.9 carapace length. Ischium expanding distally, upper margin almost straight, unarmed; lower margin with row of 4 similar spines. Merus little shorter than ischium, 1.5 times as long as wide (tooth excluded), ovate; upper margin convex, unarmed, carinate; lower margin with proximal angled spine, carinate over distal three quarters. Carpus 0.65 as long as wide; upper and lower margins carinate. Propodus upper margin 1.7 times as long as carpus; palm widest at midpoint, wider than carpus, as long as wide; upper margin convex, with narrow rounded keel; lateral surface smooth, convex; mesial surface convex, distolateral margin with tubercle near base of fixed finger; lower margin carinate, with row of setae extending onto fixed finger; fixed finger half as long as palm, distally directed; cutting edge lateral, blade-like, ending in step two thirds along. Dactylus as long as fixed finger, hooked distally, with acute tip; upper margin ridged, with tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge unarmed.

Minor cheliped unknown.

Pereopod 2 merus lower margin almost straight, 2.5 times as long as wide; carpus about 1.8 times as long as wide; chela subtriangular; palm about 1.7 times as wide as upper margin; dactylus 2.2 times as long as palm upper margin. Pereopod 3 merus 2.5 times as long as wide; carpus subtriangular, 1.7 times as long as wide; propodus oval, upper margin as long as greatest width, lower margin rounded over proximal half, distal half sinusoidal, marginal setae with 2 clear gaps along distal half, with 1 slender spiniform seta subdistally; dactylus about 0.6 length of propodus upper margin. Pereopod 4

propodus about 3.8 times as long as wide. Pereopod 5 chelate.

Pleopods of female 1, 2 typical. Pleopods 3–5 biramous, endopod 2.3 times as long as wide; appendix interna slender, rod-like, projecting well beyond mesial margin of endopod.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval-tapering, widest at midpoint, about 1.6 times as long as wide; upper surface with 1 long proximal spiniform setae on dorsal rib; anterior margin almost straight ending in small tooth; anterodistal margin with 2 short spiniform setae; distal margin convex, with fringe of setae; posterior margin setose. Exopod widest near midpoint, 1.6 times as long as wide, exceeding endopod by one third its length; anterior margin almost straight; all margins with numerous slender setae, with more than 10 blade-like setae on posterior margin indistinguishably merged with distal margin; dorsal plate apparent near distal margin as row of about 7 stiff setae.

Telson trapezoidal, as wide as long, broadest at anterior fifth, narrowing posteriorly; greatest width 1.4 times posterior width; posterolateral angle each with 2 spiniform setae; posterior margin medially excavate, with median tooth; dorsal surface with few medial setae including pair of spiniform setae.

**Etymology.** From the Gulf of Huon, Papua New Guinea.

**Distribution.** Solomon Sea (Papua New Guinea); 462–495 m.

**Remarks.** *Rayllianassa huonensis* shares with *R. bifida* sp. nov. a proximal spine on the merus of the major cheliped but lacks the strong cheliped carina and bifid cheliped dactylus seen in this species. The new species is also genetically and morphologically close to *Rayllianassa* sp. (see below).

### *Rayllianassa* sp.

Figures 37b, 46

*Rayllianassa* cf. *amboinensis*.—Robles et al., 2020: fig. 3 (part).

**Material examined** by P.C. Dworschak. **Philippines**, Luzon, 14° 53' N, 121° 45' E, 269–277 m (MNH AURORA 2007 stn CP2671), NHMW 25915\* (tissue sample ULLZ 10127), (ovigerous female, 4.3 mm).

**Diagnosis.** Antennular peduncle about as long as antennal peduncle. Major cheliped merus with simple proximal tooth and carinate along most of lower margin; carpus and merus upper margins carinate; palm upper margin with narrow rounded keel, without tubercles and ridges on distal mesial and lateral margins at the base of fingers; dactylus with blade along cutting edge, apex simple. Pereopod 3 propodus oval, widest proximally. Uropodal exopod widest near midpoint, 1.2 times as long as wide; endopod elongate-oval, twice as long as wide.

**Remarks.** Peter C. Dworschak (pers. comm., 26 September 2022) provided sketches of this individual that is included in the molecular phylogram of Robles et al. (2020: fig. 3). It is similar to *R. huonensis*. The major cheliped of the two species are similar (merus with a basal spine, distomesial margin of the palm with a tubercle) but the uropods differ – *R. huonensis* has a relatively narrower exopod and wider endopod with a long spiniform seta on the dorsal face. Sequences of the two species diverge significantly (12S: 0.031; 16S: 0.050; Table 2). The dorsal carapace and pleon is reddish; the chelipeds have a pale orange distal transverse band on the carpus and palm (fig. 37b).

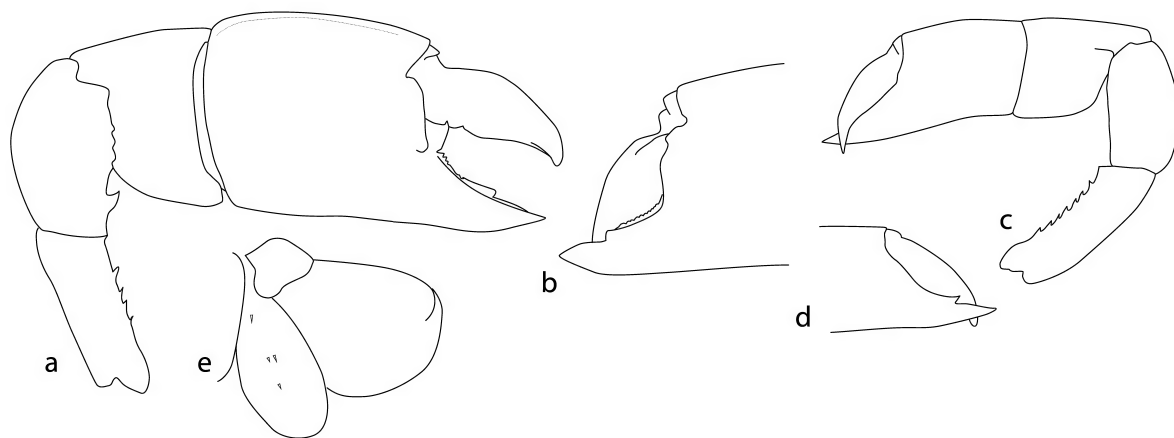


Figure 46. *Rayllianassa* sp. Philippines. NHMW 25915 (ovigerous female, 4.3 mm: a, major cheliped (left, mesial); b, major cheliped distal palm, fingers (lateral); c, minor cheliped (right, mesial); d, minor cheliped distal palm, fingers (lateral); e, right uropod (from drawings by P.C. Dworschak).

***Rudisullianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019**

*Rudisullianassa* Poore et al., 2019: 98–99.—Robles et al., 2020: figs 1, 3, 6.—Poore and Ahong, 2023: 213.

**Diagnosis.** Hermaphrodite. Rostrum obsolete or obtusely triangular, flat, not reaching cornea. Cervical groove suture-like dorsally. Antennular peduncle exceeded by distal half of antennal peduncular article 5. Antennal scaphocerite simple, about as long as wide, apically rounded. Maxilliped 3 ischium-merus 1.5 times as long as wide; merus wider at ischium-merus suture than long; dactylus tapering, with scattered setae over upper margin, dense brush of short setae distally on lower margin *or* ovate, with dense brush of long setae over most of upper-distal margin, few setae along lower margin. Major cheliped merus widest distally, lower margin with or without denticles. Minor cheliped half width of major cheliped, both swollen; carpus upper margin shorter than propodus. Uropodal endopod ovoid, longer than wide, anterior margin straight, posterodistal margin evenly convex, with or without facial spiniform setae on rib. Uropodal exopod about as long as wide or about 1.5–1.8 times as long as wide, posterodistal margin with row of 6–8 long blade-like setae proximal to long setae on distal margin. Telson about as wide as long, tapering from anterolateral lobe; anterolateral lobe obsolete, undefined; posterior margin slightly concave, without medial spine.

**Remarks.** Poore et al (2019) diagnosed *Rudisullianassa*. *Rudisullianassa rudisulcus* (Komai, Fujita and Maenosono, 2014) and *R. pandan* sp. nov. are sister species in the molecular phylogram of Robles et al. (2020: fig. 3). Their closest neighbour in this analysis is *Scallasis* Bate, 1888 (see Komai et al., 2020 for rediagnosis). Morphologically, *Rudisullianassa* is most similar to *Rayllianassa*, differing in having the antennal peduncle longer than the antennular peduncle (vice versa or as long as each other in *Rayllianassa*). Both genera are rediagnosed here but are hard to distinguish morphologically despite the apparent molecular separation.

Komai et al. (2014a) recorded *R. rudisulcus* from soft sediment, inferring the species was a sediment burrower as is typical of callianassids. Most of the records of the same species and a second from Papua New Guinea noted the presence of wood in the sample or that the shrimp was extracted from mud surrounding *Pandanus* roots. This suggests that both species burrow next to wood, as do some species of *Rayllianassa*.

Komai et al. (2014a) reported only one specimen of the type species, *Rayllianassa rudisulcus*, an ovigerous female. All the new material of this species and of a second species have both female and male gonopores, even while ovigerous.

***Rudisullianassa pandan* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:39DA749A-D7B1-4A40-A246-34F1BA361BC4>

Figures 1h, 4f

*Rudisullianassa* PNG-369.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** Holotype. **Papua New Guinea**, Madang Province, S of Tab I., 05° 10.3' S, 145° 50.3' E, 2–4 m, associated with *Pandanus* wood (PAPUA NIUGINI stn PR22), MNHN IU-2013-7054\* (female,

4.2 mm). Paratypes. Collected with holotype, MNHN IU-2013-7063\*# (female without pleon, 4.5 mm), MNHN IU-2013-437 (ovigerous female, 3.52 mm), MNHN IU-2017-1347 (10 hermaphrodites, 3–4 mm), MNHN IU-2017-1348\*# (hermaphrodite, 4.7 mm), MNHN IU-2017-1349 (ovigerous female, 3.6 mm), MNHN IU-2017-1350 (ovigerous female, 3.5 mm), NMV J71657 (2 hermaphrodites, 3.5, 3.9 mm). Other material. **Papua New Guinea**, Madang Province, (PAPUA NIUGINI stn PR58), MNHN IU-2013-7132 (female, 4.3 mm).

**Description.** Rostrum barely projecting, situated level with dorsal carapace, as long as eyestalks. Carapace dorsally flat, as long as pleomeres 1 and 2 and half of pleomere 3 combined; orbital margin transverse; anterolateral angle not projecting, obtuse; subanterolateral margin oblique, anterior margin of branchiostegite with dorsal lobe; cervical groove across 0.85 length of carapace, reaching linea thalassinica, scarcely incised in lateral view. Thoracic sternite 7 subpentagonal with projecting anteromedian margin; ventral surface without median groove; posterior margin with negligible median indentation. Pleomere 1 tergite narrowest anteriorly. Pleomere 2 slightly wider than long. Pleomeres 3–5 each wider than long; pleura each with patch of plumose setae. Pleomere 6 about as long as wide, 1.1 times as long as pleomere 5, with obsolete ventrolateral groove.

Eyestalk 1.3 times as long as wide, tapering, with gently sloping anterior face, anteromesial angle rounded in dorsal view, reaching distal margin of antennular peduncle article 1. Cornea occupying anterolateral margin of eyestalk, darkly pigmented.

Antennular peduncle almost reaching distal margin of antennal peduncle article 5; article 1 scarcely visible in dorsal view; article 2 shorter than article 1; article 3 1.5 times as long as articles 1 and 2 combined; articles 2 and 3 with longitudinal ventral row of sparse long setae. Antennal peduncle article 5 0.8 length of article 4; scaphocerite minute, oval.

Maxilliped 3 ischium distally expanded, about as long as wide, crista dentata consisting of row of 20 small similar teeth; merus about 0.6 length of ischium measured along outer margin, about twice as wide as long, with mesiodistal lobe overreaching articulation of carpus; carpus shorter than merus; propodus oval, 1.4 times as long as wide; dactylus ovoid, 0.9 length of propodus, twice as long as wide, with dense setae over distal margins.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped massive, carpus-palm upper margin 1.4 times carapace length. Ischium expanding distally, upper margin concave, unarmed; lower margin with obsolete teeth. Merus 1.2 times as long as ischium, 1.6 times as long as wide, vase-shaped; upper margin convex, unarmed; lower margin with oblique distal lobe, armed with few small teeth. Carpus 1.7 times as wide as long; margins carinate, folding mesially. Propodus upper margin 2.8 times as long as carpus; palm of almost even width, 1.45 times as long as wide; upper margin with slight mesial carina; lateral surface smooth, convex, distal margin with 2 blunt rounded teeth at base of finger; mesial surface convex, with small tooth at base of finger; lower margin carinate, with row of clusters of setae extending onto fixed finger; fixed finger about half as long as palm, convex, depressed and angled mesially beyond palm; cutting edge lateral, uneven. Dactylus not overreaching fixed finger;

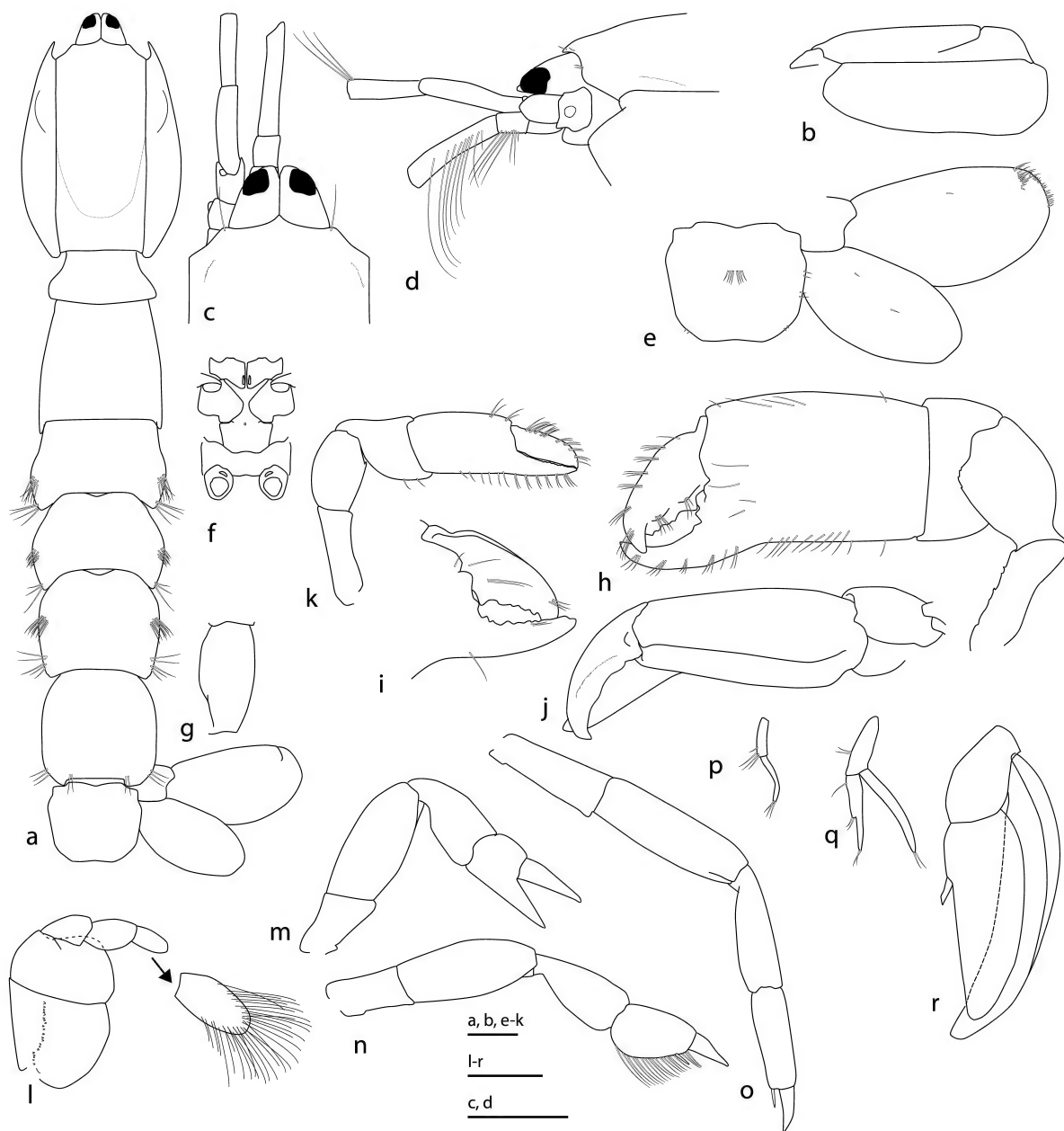


Figure 47. *Rudisullianassa pandan* sp. nov. Papua New Guinea. MNHN IU-2013-7054, female, 4.2 mm: a, eyestalks, carapace, pleon, telson, uropod; b, eyestalk, carapace (lateral); c, d, antennular peduncle, antennal peduncle, eyestalk, anterior carapace (dorsal, lateral); e, telson, right uropod; f, thoracic sternites 7, 8, pereopodal coxae 3–5 (gonopores shaded); g, pleomere 6 (left lateral); h, major cheliped (right, mesial); i, major cheliped distal palm, fingers (lateral); j, carpus–dactylus (upper); k, minor cheliped (left, mesial); l, maxilliped 3 (with detail of dactylus); m–o, pereopods 2–4; p–r, pleopods 1–3. Scale bars = 1 mm.

upper margin with tufts of long setae; cutting edge with triangular blunt proximal tooth, irregularly tooth blade over distal third, with blunt hooked tip.

Minor cheliped carpus-palm upper margin about as long as that of major cheliped. Ischium margins smooth. Merus 0.75 times as long as ischium; lower margin convex with small tooth about two thirds along. Carpus widest over distal half, almost as long as merus, 1.2 times as long as wide. Palm 1.5 times as long as wide; upper margin barely convex; lower margin sharply carinate, with row of long setae extending onto fixed finger; lateral face smooth. Fixed finger 0.7 length of palm, cutting edge denticulate. Dactylus 0.74 length of fixed finger; cutting edge smooth.

Pereopod 2 merus with convex margins, 2.2 times as long as wide; carpus subtriangular, twice as long as wide; palm 1.3 times as wide as upper margin; dactylus 1.7 times as long as palm upper margin. Pereopod 3 carpus subtriangular, twice as long as wide; propodus widest proximally, tapering, without produced lower proximal margin, upper margin 1.4 times width, lower margin convex, with 1 slender subdistal spiniform seta, with evenly spaced marginal setae; dactylus nearly straight, about 0.6 length of propodus upper margin. Pereopod 4 coxa flattened ventrally, immovable; merus 1.4 times as long as ischium; carpus 0.8 length of merus; propodus 0.8 length of carpus, with dense grooming setae distally on lower margin, scattered stiff setae on outer surface, with long spiniform setae parallel to dactylus; dactylus straight, half as long as propodus. Pereopod 5 slender, subchelate.

Female pleopod 1 of 2 articles, second weakly curved. Female pleopod 2 biramous; peduncle almost straight; endopod tapering distally, slightly shorter and broader than exopod, of 2 articles. Pleopods 3–5 biramous, rami narrow; appendix interna slender, rod-like, projecting well beyond mesial margin of endopod, bearing coupling hooks on apical margin.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval, about 1.65 times as long as wide; upper surface with 2 spiniform setae; anterior margin slightly convex; posterodistal margin convex, with fringe of setae. Exopod oval, 1.6 times as long as wide, exceeding endopod by about one third length; anterior margin convex, with 4 submarginal slender setae; posterior margin with numerous slender setae, with about 7 blade-like distal setae, indistinguishably merged with distal margin; upper surface with 1 spiniform seta; dorsal plate short, with row of about 10 stiff setae separate from setal row of distal margin.

Telson 1.2 times as long as wide, broadest at anterior fifth, narrowing posteriorly to oblique posterolateral angles, each with 2 small spiniform setae; posterior margin weakly concave; dorsal surface with few medial setae anterior to midlength.

**Etymology.** Pandan, a Malay word from which the palm genus *Pandanus* is derived (noun in apposition).

**Distribution.** Eastern Coral Triangle (Papua New Guinea); 2–4 m, associated with submerged wood.

**Remarks.** *Rudisullianassa pandan* differs from *R. rudisulcus* in having (1) narrower uropodal rami; (2) relatively shorter telson;

(3) the tooth on the distolateral margin of the palm of the major cheliped less prominently triangular; (4) the distal margin of the merus of maxilliped 3 not as produced and the dactylus not as densely distally setose; and (5) the propodus of pereopod 3 more symmetrical (it is wider proximally in *R. rudisulcus*).

Both species occur in Madang Province, Papua New Guinea, and were taken from a single sample associated with submerged pandanus wood.

### ***Rudisullianassa rudisulcus* (Komai, Fujita and Maenosono, 2014)**

Figures 1i, 48

*Rayllianassa rudisulcus* Komai et al., 2014a: 554–560, figs 3–7.

*Rudisullianassa rudisulcus*.—Poore et al., 2019: 140, 143.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** Papua New Guinea, Madang Province, S of Tab I., 05° 10.3' S, 145° 50.3' E, 2–4 m (PAPUA NIUGINI stn PR22), MNHN IU-2013-435\* (ovigerous female, 4.4 mm), MNHN IU-2013-7060\* (hermaphrodite, 3.7 mm), MNHN IU-2013-7069\* (ovigerous female, 4.0 mm), MNHN IU-2017-1345 (7 hermaphrodites, 2 ovigerous females, 2.9–3.7 mm), NMV J71663 (3 hermaphrodites, 1 ovigerous female, 2.9–3.8 mm). Kranket I., 05° 11.5' S, 145° 49.5' E, 10–20 m (PAPUA NIUGINI stn PR58), MNHN IU-2013-7088\* (2 ovigerous females, 3.4 mm), MNHN IU-2013-7042\* (ovigerous female, 4.4 mm), MNHN IU-2013-7131 (ovigerous female, 3.7 mm), MNHN IU-2013-7121 (hermaphrodite, 3.8 mm). N of Madang, intertidal 04° 59.3' S, 145° 47.6' E (PAPUA NIUGINI stn PM27), MNHN IU-2013-7057 (ovigerous female, 2.9 mm).

**Diagnosis.** Telson as long as wide, broadest at anterior third, narrowing posteriorly to rounded posterolateral angles; dorsal surface with few medial setae anterior to midlength; posterolateral angle with row of small spiniform setae; posterior margin convex. Uropod endopod oval, about 1.4 times as long as wide; upper surface without spiniform setae. Exopod oval, 1.4 times as long as wide, with row of submarginal slender setae; posterior margin with numerous slender setae, with 3 blade-like distal setae; upper surface with 1 spiniform seta near midpoint.

**Distribution.** South Kurishio, Eastern Coral Triangle (Ryukus, Japan [type locality: Ohura Bay, Okinawa I., 3–20 m]; Papua New Guinea); 0–20 m; associated with submerged wood.

**Remarks.** The species description and figures are comprehensive (Komai et al., 2014a) and little needs to be added. The maxilliped 3 dactylus is short and bears dense setae over the distal and upper margins, much denser than in *R. pandan*, and resembles the condition in eucalliids. Komai et al. (2014b) figured the female pleopod 2 with a 2-articled exopod; all of the new material has only one article, as is typical of callianassids (fig. 41h). The major chela is mesially twisted and its palm is characterised by a lateral triangular tooth in the gape (fig. 41c–e).

### ***Spinicallianassa* Poore, Dworschak, Robles, Mantelatto and Felder, 2019**

*Spinicallianassa* Poore et al., 2019: 99–100.—Robles et al., 2020: figs 1, 3, 6.—Poore and Ahyong, 2023: 214.

**Remarks.** Species of *Spinicallianassa* have an acute rostrum. Larger adults of most species have a longitudinal groove, sometimes well defined by a sharp ridge, on the lateral face of the palm running onto the fixed finger. The eyestalk is more swollen and convex laterally than in other callianassid genera except *Cavallianassa*, which it somewhat resembles; *Spinicallianassa* differs from *Cavallianassa* in having a spine between a third and half way along the lower margin of the cheliped merus rather than smaller subproximal spine(s). A feature of most species is the small tubercle at the lower limit of the distomesial margin of the cheliped palm.

Robles et al. (2020) recognised three undescribed species of which one, *S. aff. acutirostella* (Sakai, 1988), is here reidentified as *S. spinicauda* (Komai, Maenosono and Fujita, 2014). Three new species, one from Papua New Guinea, a second principally from French Polynesia, and a third from southwestern Australia are described as new. The identity of *S. acutirostella* remains problematic (see below). Differences between the species are slight, and were it not for the genetic separation all could be viewed as one variable species. The best illustrated species is *S. spinicauda* (Komai, Maenosono and Fujita, 2014). The diagnoses below concentrate on few critical characters.

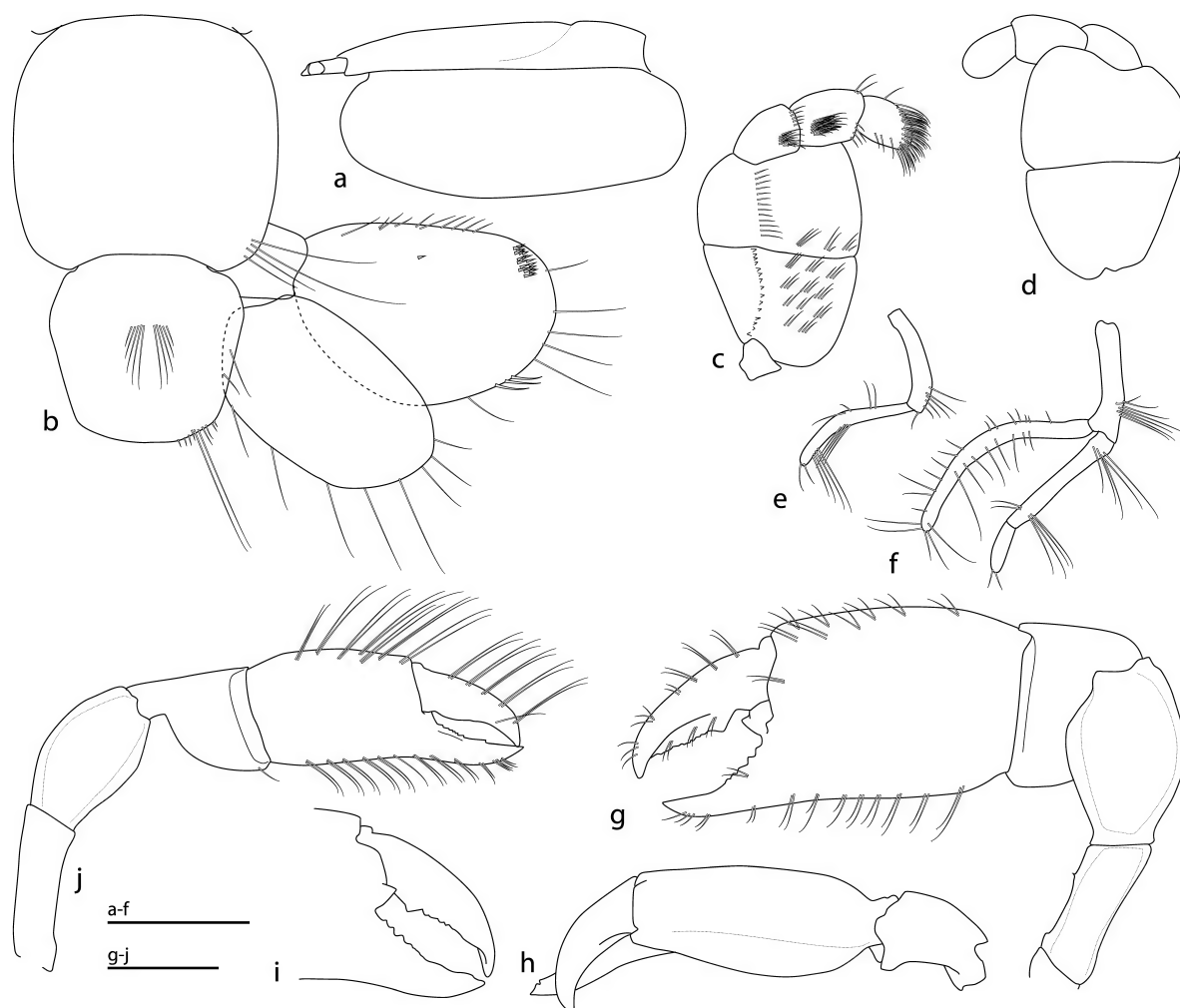


Figure 48. *Rudisullianassa rudisulcus* Komai, Fujita and Maenosono, 2014. Papua New Guinea. MNHN IU-2013-7121, hermaphrodite, 3.8 mm: a, eyestalk, carapace. MNHN IU-2013-435, ovigerous female, 4.4 mm: b, pleomere 6, telson, right uropod; c, d, maxilliped 3 (mesial, outer views); e, f, pleopods 1, 2; g, major cheliped (right, mesial); h, major cheliped carpus-dactylus (upper); i, major cheliped distal palm, fingers (lateral); j, minor cheliped (left, mesial). Scale bars = 1 mm.

### Key to species of *Spinicallianassa*

*S. parvula* excluded

1. Uropodal exopod distal margin convex, with obtuse angle between it and anterior margin; anterior margin with 1–3 distal spiniform setae plus fine setae; dorsal plate of few spiniform setae ..... 2
- Uropodal exopod distal margin straight, with right angle between it and anterior margin; anterior margin with only fine setae; dorsal plate of numerous spiniform setae ..... 4
2. Telson 1.2 times as long as wide. Uropodal exopod with 2 or 3 well spaced spiniform setae along anterior margin ..... *S. westralia*
- Telson 1.4–1.6 times as long as wide. Uropodal exopod with 1 or 2 distal spiniform setae along anterior margin ..... 3
3. Maxilliped 3 merus rectangular ..... *S. bilbili*
- Maxilliped 3 merus semicircular ..... *S. acutirostella*
4. Telson posterolateral corners rounded; without short dorsal spiniform setae ..... *S. papetoi*
- Telson posterolateral corners squarish; with row of short dorsal spiniform setae ..... *S. spinicauda*

### *Spinicallianassa acutirostella* (Sakai, 1988)

Figure 49

*Callianassa acutirostella* Sakai, 1988: 57–59, fig. 2.—Sakai, 1999: 37.—Tudge et al., 2000: 143.—Davie, 2002: 458.

*Trypaea acutirostella*.—Sakai, 2011: 390.

*Cheramus acutirostella*.—Komai et al., 2014b: 522, fig. 16.

*Spinicallianassa acutirostella*.—Poore et al., 2019: 140, 143.

Not *Callianassa acutirostella*.—Sakai, 2005: 64–68, figs 13, 14 (= *Spinicallianassa spinicauda* (Komai, Maenosono and Fujita, 2014).

**Material examined.** Australia, WA, North West Shelf, 19° 05.1' S, 118° 53.7' E, 82 m, NTMAG Cr000789 (holotype female, 4.5 mm).

**Diagnosis.** Telson 1.35 times as wide as long, with dorsal transverse row of long setae and 3 pairs of spiniform setae, anterolateral lobes rounded, lateral margins tapering to angular posterolateral corners; posterior margin almost truncate. Uropodal endopod 1.7 times as long as wide, with 4 or 5 scattered spiniform setae on face, without spiniform setae along anterodistal margin; anterior margin with or without subdistal tooth. Uropodal exopod 1.2 times as long as wide, distal margin at right angles to anterior margin, dorsal plate comprising numerous dense spiniform setae, anterior margin without distal spiniform seta. Maxilliped 3 ischium 1.0–1.2 times as long as wide; merus almost semicircular.

**Distribution.** Northwest Australian Shelf (Australia, WA [type locality: North West Shelf, 82 m]); 82 m.

**Remarks.** *Callianassa acutirostella* was described from a single female without pereopods, reillustrated here in part. The original description (Sakai, 1988) illustrated (unconvincingly) the two pairs of prominent spiniform setae

on the face and the row of about 16 short spiniform setae on each half of the posterior margin of the telson, figured in more detail from the holotype by Komai et al. (2014b) who transferred the species to *Cheramus*. The uropodal endopod has three long and one short spiniform setae on the anterodistal margin plus two long facial spiniform setae on the longitudinal ridge; the exopod has spiniform setae of various lengths on the posterodistal margin and the margin of the dorsal plate, plus a single facial spiniform seta. The scaphocerite is minute and triangular.

### *Spinicallianassa bilbili* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:66725744-228A-433E-8432-2C745FA73747>

Figure 50

*Spinicallianassa* PNG-757.—Robles et al., 2020: figs 1, 3, 6.

**Material examined.** Holotype. Papua New Guinea, Madang Province, S of Madang, near Bil Bil I., 05° 18' S, 145° 46.1' E, 17 m (PAPUA NIUGINI stn PB29), MNHN IU-2013-842\* (ovigerous female, 3.3 mm).

**Diagnosis.** Telson 1.4 times as wide as long, with dorsal transverse row of long setae, anterolateral lobes angular, lateral margins tapering to angular posterolateral corners; posterior margin truncate. Uropodal endopod 1.7 times as long as wide, with 2 well-spaced spiniform setae on face, with 5 along anterodistal margin; anterior margin without subdistal tooth. Uropodal exopod 1.5 times as long as wide, distal margin convex, dorsal plate comprising 5 spiniform setae, anterior margin with 2 distal spiniform setae. Maxilliped 3 ischium 1.8 times as long as wide; merus rectangular.

**Description of holotype.** Rostrum spine-like, situated at level of dorsal carapace, almost as long as eyestalk. Carapace dorsally weakly convex in lateral view, as long as pleomeres 1 and 2 combined; orbital margin oblique, convex; anterolateral lobe prominent; subanterolateral margin oblique; anterior margin of branchiostegite evenly convex; cervical groove deeply incised, across 0.9 length of carapace, not reaching linea thalassinica. Pleomere 1 tergite with shallow transverse groove, much narrower anteriorly. Pleomere 2 twice as long as pleomere 1. Pleomere 6 about as long as wide.

Eyestalk about as long as wide, with dorsal face strongly depressed anteriorly (basally about three quarters as high as wide), with sharp ventrolateral margin, lateral margin swollen proximal to cornea, anteromedial angle rounded in dorsal view, overreaching distal margin of antennular peduncle article 1. Cornea densely pigmented, occupying mid-distal of eyestalk.

Antennular peduncle little shorter than antennal peduncle; article 1 scarcely visible in dorsal view; article 3 about as long as articles 1 and 2 combined; article 2 with dense longitudinal ventral row of long setae; article 3 with well-spaced ventral setae. Antennal peduncle article 5 0.6 length of article 4; scaphocerite acute.

Maxilliped 3 ischium slightly narrower distally, 1.8 times as long as wide, crista dentata comprising 6 strong curved teeth over proximal half, 9 smaller closer teeth over distal half; merus 0.5 length of ischium measured along outer margin, as wide as



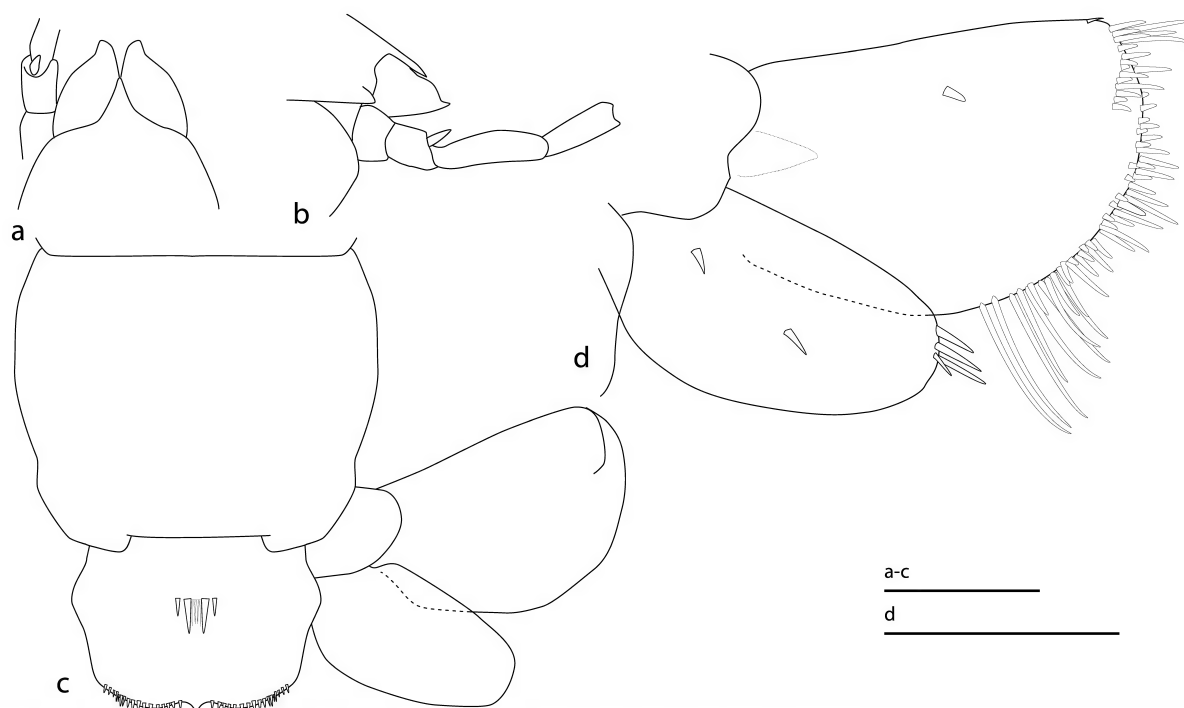


Figure 49. *Spinicallianassa acutirostella* (Sakai, 1988). Australia, North West Shelf. NTMAG Cr000789, holotype female, 4.5 mm: a, b, rostrum, antennal peduncle, eystalk; c, pleomere 6, telson, uropod; d, right uropod. Scale bars = 1 mm.

long, wider than ischium, with mesiodistal margin oblique, separated from inner margin by distinct rounded corner; carpus as long as merus outer margin; propodus ovoid-tapering, 1.7 times as long as wide; dactylus tapering, shorter than propodus, with scattered setae along upper margin, dense row of short setae along distal lower margin.

Pereopods 1 (chelipeds) unequal, similar. Major cheliped carpus-palm upper margin 0.9 carapace length. Ischium scarcely expanding distally, upper margin almost straight, unarmed; lower margin with row of five similar spines. Merus as long as ischium, 1.7 times as long as wide (tooth excluded), ovate; upper margin convex, unarmed; lower margin with oblique spine near midpoint. Carpus 1.1 times as long as wide; upper margin carinate; lower margin carinate. Propodus upper margin as long as carpus; palm 1.1 times as long as wide; upper margin convex, ridged; lateral surface smooth, convex, with slight concavity at base of finger; distolateral margin of palm slightly convex; mesial surface convex, distomesial margin transverse, set back from distolateral margin; lower margin carinate, with row of setae extending onto fixed finger; fixed finger 0.65 length of palm, triangular; cutting edge lateral, an irregular blade, with minor more medial ridge. Dactylus as long as fixed finger, straight, with acute tip; upper margin ridged, with tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge with irregular small teeth.

Minor cheliped carpus-palm upper margin 0.8 carapace length. Ischium upper margin smooth, lower margin with row of six spines. Merus about as long as ischium; lower margin with oblique spine at midpoint. Carpus wider distally, about as long as merus, 1.5 times as long as wide, upper and lower margins carinate. Palm as long as wide; upper margin convex, ridged; lower margin carinate, with row of long setae extending onto fixed finger; distomesial margin oblique. Fixed finger 0.7 length of palm, cutting edge lateral, with small irregular teeth, with minor more mesial ridge. Dactylus tapering, curved, unarmed.

Pereopod 2 merus lower margin slightly sinusoidal, 2.5 times as long as wide; carpus about 1.6 times as long as wide; chela subtriangular; palm about 1.7 times as wide as upper margin; dactylus twice as long as palm upper margin. Pereopod 3 unknown. Pereopod 4 coxa flattened ventrally, distal articles linear. Pereopod 5 chelate.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval, widest near midpoint, 1.7 times as long as wide; upper surface with 2 spiniform setae on dorsal rib; anterior margin almost straight; distal margin evenly convex, with spiniform setae at anterodistal margin; posterior margin setose. Exopod widest near midpoint, 1.4 times as long as wide, exceeding endopod by one quarter its length; anterior margin straight; all margins with numerous slender setae, with about 15 blade-like setae on posterior

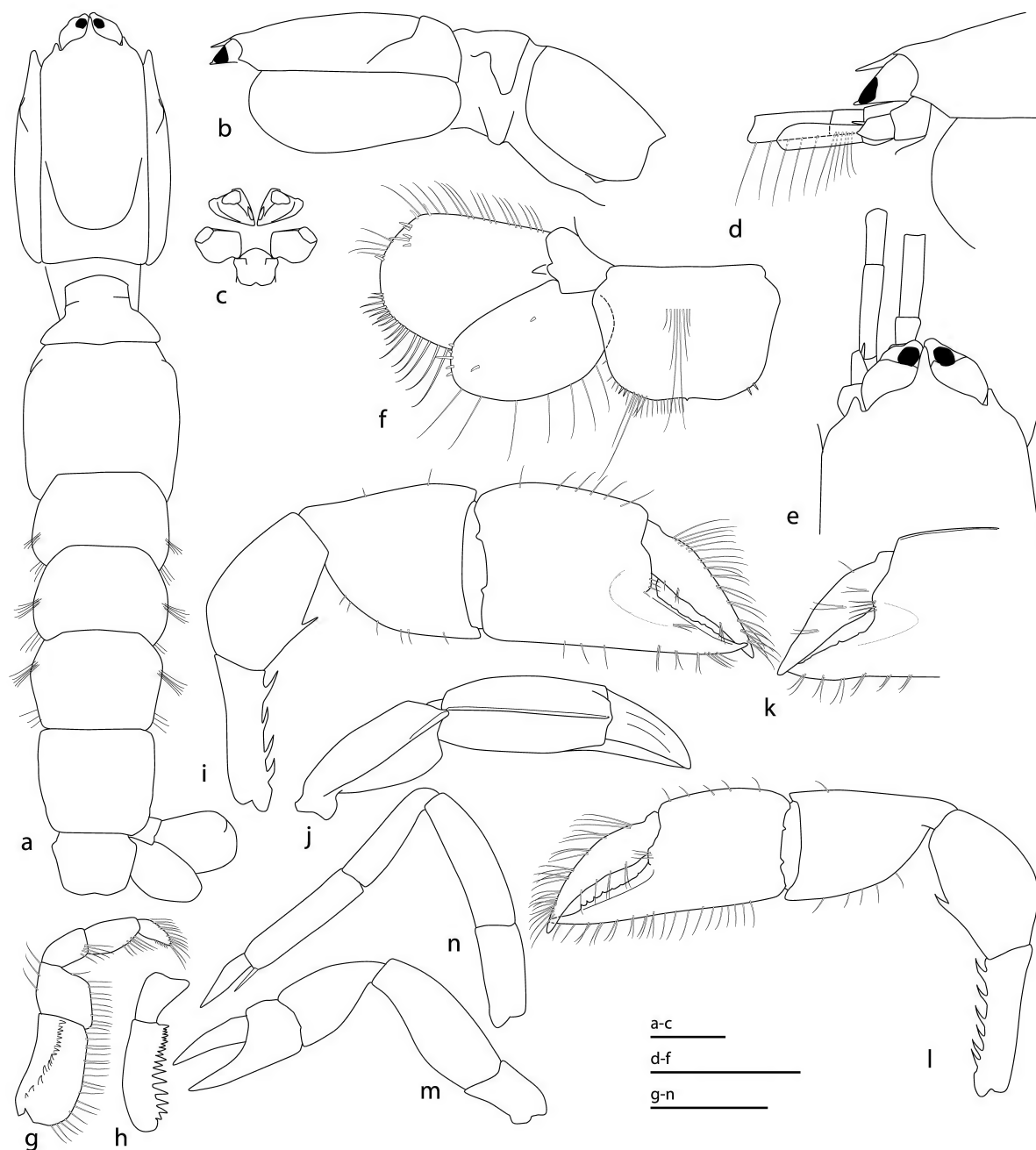


Figure 50. *Spinicallianassa bilbili* sp. nov. Papua New Guinea. MNHN IU-2013-842, holotype ovigerous female, 3.2 mm: a, eyestalks, carapace, pleon, telson, uropod; b, eyestalks, carapace, pleomeres 1, 2 (lateral); c, thoracic sternite 7, pereopodal coxae 3, 4; d, e, anterior carapace, eyestalks, antennular, antennal peduncles (lateral, dorsal); f, telson, left uropod; g, maxilliped 3 (inner view); h, maxilliped 3 ischium, merus (mesial view); i, major cheliped (left, mesial); j, major cheliped carpus–dactylus (upper); k, major cheliped distal palm, fingers (lateral); l, minor cheliped (right, mesial); m, pereopod 2; n, pereopod 4. Scale bars = 1 mm.

margin indistinguishably merged with distal margin; dorsal plate apparent near distal margin as row of about 7 irregularly spaced stiff setae.

Telson 1.4 times as wide as long, broadest at anterior fifth, narrowing posteriorly to broadly rounded posterolateral corners; posterolateral corners each with 2 spiniform setae; posterior margin excavate, with minute median tooth; dorsal surface with few medial setae.

*Etymology.* Contraction of Bil Bil Island, Papua New Guinea, type locality (noun in apposition).

*Distribution.* Eastern Coral Triangle (Papua New Guinea); 17 m.

*Remarks.* The molecular analysis (Robles et al., 2020: fig 3) placed this single specimen on a clade sister to seven closely clustering representatives of *S. aff. acutirostella*, reidentified here as *S. spinicauda*. *Spinicallianassa bilbili* differs from *S. spinicauda* in having a much narrower maxilliped 3 (ischium almost twice as long as wide; about as long as wide in *S. spinicauda*), a more triangular rostrum (narrow), rounded distomesial lobes on the eyestalks (acute), the telson with two pairs of distolateral spiniform setae (6–7 pairs of distal marginal spiniform setae), and uropodal endopod with two facial spiniform setae (five spiniform setae in two rows).

### *Spinicallianassa papetoi* sp. nov.

<http://zoobank.org/urn:lsid:zoobank.org:act:BF71A89C-426F-4F45-B415-EEA6BA898246>

Figures 11, 51, 52

*Spinicallianassa* FP-10.—Robles et al., 2020: figs 1, 3, 6.

*Material examined.* Holotype. **French Polynesia**, Moorea, Papetoi lagoon, 17.490867° S, 149.882879° E (FMNH stn BIZ-109), UF 23875 (ovigerous female, 5.3 mm). Paratypes. French Polynesia, Moorea (all FMNH stations): Papetoi, 17.489800° S, 149.884° W (stn BIZ-463), UF 28785\*# (ovigerous female, 4.5 mm), UF 28821\* (juvenile, 2.9 mm), UF 28822\* (ovigerous female, 4.200 mm); (stn BIZ-493), UF 28905\* (ovigerous female, 4.3 mm). Papetoi, 17.491100° S, 149.884400° W (stn MIB-195), UF 16285 (ovigerous female, 4.5 mm), UF 16299 (female, 4.9 mm). SW of Motu, 17.494° S, 149.921° W (stn BIZ-474), UF 28787 (female, 3.6 mm). Motu I. Channel, 17.489210° S, 149.913140° W (stn BIZ-676), UF 29277 (female, 5.1 mm). Haapiti, mangrove area, 17.556680° S, 149.874400° W (stn MIB-054), UF 15733 (ovigerous female, 5.7 mm). Motu Tiahura/Fareone channel, 17.488800° S, 149.913400° E, (stn MIB-226), UF 16508 (ovigerous female, 4.4 mm), UF 16509 (female, 5.2 mm). Other material (all females, many ovigerous, not measured). **French Polynesia**, Moorea (all FMNH stations). Papetoi lagoon, 17.490867° S, 149.882879° W (stn BIZ-109), UF 23877. Papetoi, 17.489800° S, 149.884° W (stn BIZ-463), (UF 28786/2, UF 28823. NW Motu, in channel between islands and beach, 17.488393° S, 149.913420° W (stn BIZ-148), UF 23947. NW Motu, in channel between islands, 17.489335° S, 149.913178° W (stn BIZ-150), UF 23946, UF 23955. Nihimauru estuary, 17.533° S, 149.904050° W (stn BIZ-158), UF 23987. Between Cook's Bay and Hilton, off Pihana, 17.481° S, 149.83° W (stn BIZ-632), UF 29192, UF 29211, UF 29212, UF 29213, UF 29214. Ray feeding site near Motu islands 17.487680° S, 149.970° E, (stn BIZ-675), UF 29259, UF 29260, UF 29261, UF 29263, UF 29266, UF 29268#, UF 29269, UF 29270, UF 29271. Motu I. Channel, 17.489210° S, 149.913140° W (stn BIZ-676), UF 29272, UF 29275, UF

29276, UF 29280. Motu Tiahura/Fareone channel, 17.4888° S, 149.9134° E, (stn MIB-226), UF 16510, UF 16511, UF 18419.

*Diagnosis.* Telson 1.3 times as wide as long, with dorsal transverse row of long setae, anterolateral lobes rounded, lateral margins tapering to broadly rounded posterolateral corners; posterior margin convex with slight medial concavity. Uropodal endopod 1.6 times as long as wide, with 10–12 scattered spiniform setae on face, especially in diagonal subdistal row, with 4 spiniform setae along anterodistal margin; anterior margin with subdistal tooth. Uropodal exopod 1.25 times as long as wide, distal margin at right angles to anterior margin, dorsal plate comprising numerous dense spiniform setae, anterior margin without distal spiniform seta. Maxilliped 3 ischium about as long as wide; merus almost semicircular.

*Description of holotype.* Rostrum spine-like, situated at level of dorsal carapace, 0.65 length of eyestalk. Carapace dorsally weakly convex in lateral view, about as long as pleomeres 1–2 combined; orbital margin transverse, well differentiated from sides of rostrum; anterolateral lobe insignificant; subanterolateral margin convex, oblique; anterior margin of branchiostegite vertical below linea thalassinica, convex ventrally; cervical groove deeply incised, across 0.8 length of carapace, not reaching linea thalassinica. Pleomere 1 tergite with shallow transverse groove, much narrower anteriorly. Pleomere 2 1.3 times as long as pleomere 1. Pleomere 6 about as wide as long.

Eyestalk 0.75 as wide as long, with dorsal face strongly depressed anteriorly (basally about three quarters as high as wide), with sharp ventrolateral margin, lateral margin swollen proximal to and opposite cornea, anteromedial angle sharply angled laterally in dorsal view, overreaching distal margin of antennular peduncle article 1. Cornea densely pigmented, occupying mid-distal half of eyestalk.

Antennular peduncle little longer than antennal peduncle; article 1 not visible in dorsal view; article 3 about as long as articles 1 and 2 combined; article 2 with dense longitudinal ventral row of long setae; article 3 with well-spaced ventral setae. Antennal peduncle article 5 0.7 length of article 4; scaphocerite acute, curved.

Maxilliped 3 ischium dilating distally, as long as wide, crista dentata comprising about 20 small, unevenly spaced teeth; merus 0.5 length of ischium measured along outer margin, twice as wide as long, with mesiodistal margin convex, reaching beyond articulation of carpus; carpus 0.9 length of merus outer margin; propodus ovoid-tapering, 1.7 times as long as wide; dactylus tapering, 0.6 length of propodus, with scattered setae along upper margin, dense row of short setae along distal lower margin.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped carpus-palm upper margin 0.9 carapace length. Ischium expanding distally, upper margin almost straight, unarmed; lower margin with row of 10 similar oblique spines. Merus as long as ischium, 1.7 times as long as wide (tooth excluded), ovate; upper margin convex, unarmed; lower margin with oblique spine one third along, denticulate beyond. Carpus 0.85 as long as wide; upper margin carinate; lower margin carinate. Propodus upper margin 1.3 times as long as carpus; palm as long as wide; upper margin convex, carinate over entire length;

lateral surface smooth, convex; distolateral margin of palm with convex lobe; mesial surface convex, distomesial margin transverse, set back from distolateral margin, with tubercle at lower limit; lower margin carinate, with row of setae extending onto fixed finger; fixed finger 0.75 length of palm, triangular; cutting edge lateral, micro serrate over proximal half, steep step before distal concavity. Dactylus as long as fixed finger, curved, with acute tip; upper margin ridged, with dense tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge unarmed.

Minor cheliped carpus-palm upper margin 0.75 carapace length. Ischium upper margin smooth, lower margin with row of 6 similar oblique spines. Merus about as long as ischium;

lower margin with oblique spine at midpoint. Carpus wider distally, 1.1 times as long as merus, 1.6 times as long as wide, upper and lower margins carinate. Palm as long as wide; upper and lower margins carinate; distomesial margin transverse. Fixed finger 0.7 length of palm, cutting edge lateral, with teeth along middle length. Dactylus tapering, curved, unarmed.

Pereopod 2 merus lower margin slightly sinusoidal, 2.7 times as long as wide; carpus 1.8 times as long as wide; chela subtriangular; palm about 1.7 times as wide as upper margin; dactylus 2.5 times as long as palm upper margin. Pereopod 3 carpus subtriangular, 1.8 times as long as wide; propodus upper margin convex, about as long as greatest width, lower

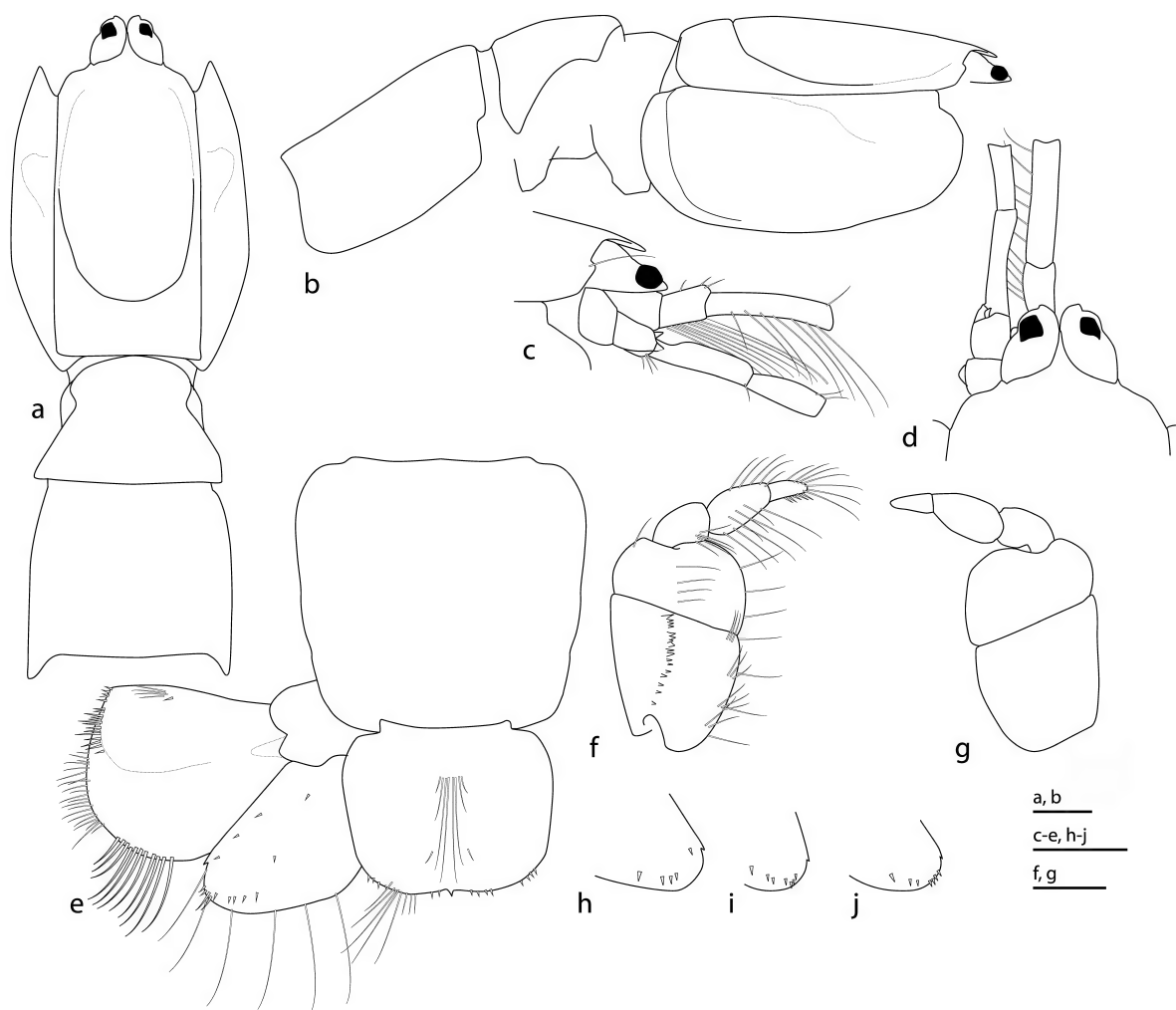


Figure 51. *Spinicallianassa papetoai* sp. nov. French Polynesia, Moorea. UF 23875, holotype ovigerous female, 5.3 mm: a, b, eyestalks, carapace, pleomeres 1, 2 (dorsal, lateral); c, d, eyestalk, antennular, antennal peduncles, anterior carapace (lateral, dorsal); e, pleomere 6, telson, left uropod; f, g, maxilliped 3 (inner, outer views). Right uropod endopod apex: h, UF 16509, female, 5.2 mm; i, UF 16508 female, 4.4 mm; j, UF 16285 ovigerous female, 4.5 mm. Scale bars = 1 mm.

margin evenly convex, with 1 slender subdistal spiniform seta, with 3 gaps between marginal setae; dactylus nearly straight, about as long as propodus upper margin. Pereopod 4 distal articles linear. Pereopod 5 chelate.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod tapered-oval, widest near midpoint, 1.5 times as long as wide; upper surface with 10 small spiniform setae (2 on dorsal rib, 3 near anterior margin, 5 near distal-posterior margin); anterior margin straight, with small distal tooth; distal margin evenly convex, with 5 spiniform setae at anterodistal margin; posterior margin convex, setose. Exopod widest near midpoint, as long as wide; anterior margin almost straight; with about 12 blade-like setae on posterior margin indistinguishably merged with distal margin; dorsal plate extending 0.4 way across exopod, heavily armed with closely packed stiff setae merging with those on distal margin; distal and posterior margins also furnished with row of fine setae; upper face without setae.

Telson 1.2 times as wide as long, broadest at anterior third, narrowing posteriorly to rounded posterolateral corners; posterior margin medially excavate, with 6–8 irregularly

spaced minute spiniform setae on each lateral half; dorsal surface with transverse row of 8 fine long setae.

**Variation.** The pattern of spiniform setae on the upper surface of the uropodal endopod varies. Two longitudinal rows of 3–5 anterior and 3 along the midrib are always present. While the number of setae near the distal-posterior margin varies as shown in fig. 51e, h–j, there is always a gap between the first and a group of 2–4.

**Etymology.** From Papetoai, type locality (noun in apposition).

**Distribution.** Southeast Polynesia (French Polynesia, Moorea); low intertidal to immediate subtidal.

**Remarks.** *Spinicallianassa papetoai* (as *S. sp.* F-10) was clearly different from two other species (here identified as *S. bilbili* and *S. spinicauda*) in the molecular analysis of Robles et al. (2020). It differs from these two and others in the shape of the eyestalk (laterally almost bilobed) and the pattern of spiniform setae on the upper face of the uropodal endopod.

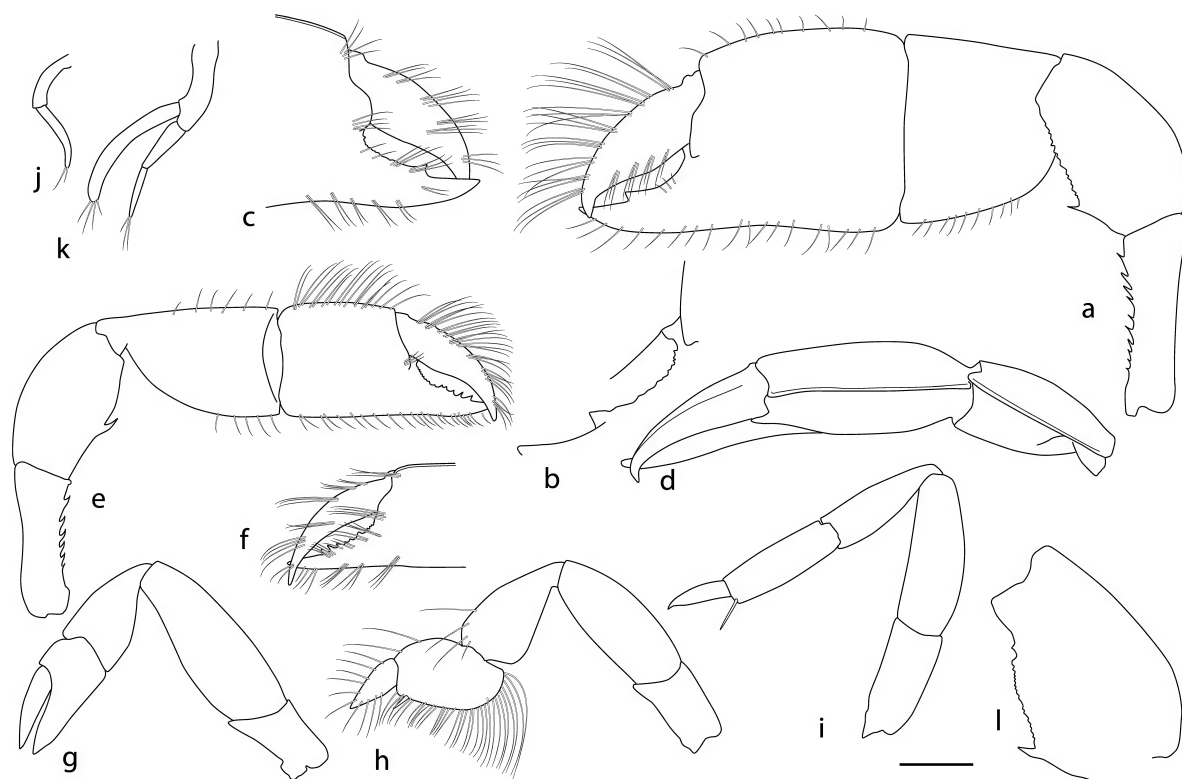


Figure 52. *Spinicallianassa papetoai* sp. nov. French Polynesia, Moorea. UF 23875, holotype ovigerous female, 5.3 mm: a, major cheliped (right, mesial); b, major cheliped (detail of gape and fixed finger); c, major cheliped fingers (lateral); d, major cheliped (carpus–dactylus, upper view); e, minor cheliped (left, mesial); f, minor cheliped fingers (lateral); g–i, pereopods 2–4; j, k, pleopods 1, 2. l, UF 16509, female, 5.2 mm, major cheliped merus (mesial). Scale bar = 1 mm.

*Spinicallianassa parvula* (Sakai, 1988)

## Figure 53

*Callianassa parvula* Sakai, 1988: 59, fig. 3.—Sakai, 1999: 50.—Tudge et al., 2000: 143.—Davie, 2002: 458.

*Cheramus parvulus*.—Sakai, 2011: 370.

*Spinicallianassa parvula*.—Poore et al., 2019: 139, 143.

**Material examined.** **Australia**, WA, North West Shelf, 19° 04.4' S, 118° 47.35' E, 83 m, NTMAG Cr000783 (holotype female, 4.0 mm).

**Distribution.** Northwest Australian Shelf (Australia, WA); 83 m.

**Remarks.** The damaged holotype lacking maxilliped 3 and chelipeds is the only specimen. The long horizontal sharp rostrum, swollen eyestalks and oval propodus on pereopod 3 are consistent with *Spinicallianassa*. The telson, reillustrated here (fig. 53), is 1.2 times as wide as long, has spiniform setae in the anterior dorsal transverse row, a pair of dorsal spiniform setae more lateral and posterior, and irregular short spiniform setae on the posterior margin, not as excavate as illustrated by Sakai (1988). The three facial setae on the uropod are confirmed (fig. 53). The specimen is a female with gonopores on the coxae of pereopods 3 and female-like pleopods 1 and 2, not a male as stated by Sakai (1988, 1999). The species may be synonymous with *S. spinicauda*.

*Spinicallianassa spinicauda* (Komai, Maenosono and Fujita, 2014)

## Figures 1k, 54–56

*Callianassa acutiostella*.—Sakai, 2005: 64 (part), figs 13, 14.—Sakai, 1999: 37 [not *Callianassa acutiostella* Sakai, 1988].

*Cheramus spinicauda* Komai et al., 2014: 505, figs 1–8.

*Trypaea acutiostella*.—Sakai, 2011: 390 (part.).

*Spinicallianassa* aff. *acutiostella*.—Robles et al., 2020: figs 1, 3, 6, tables S1, S2.

*Spinicallianassa spinicauda*.—Poore et al., 2019: 140, 143.—Robles et al., 2020: table S2.—Dworschak, 2022: 253–255, fig. 2.

**Material examined.** **Papua New Guinea**, Madang Province, Riwo, 05° 09' S, 145° 48.2' E, 1–3 m (PAPUA NIUGINI stn PR195), MNHN IU-2013-7064\*# (female, 7.5 mm); MNHN IU-2013-7083 (female, 6.9 mm); MNHN IU-2013-7115\* (female, 4.0 mm). Kavieng Province (KAVIENG 2014 stations), Kavieng Lagoon, Nago I. Wharf, 02° 36.3' S, 150° 46.2' E, 3–12 m (stn KR06), MNHN IU-2016-8147\* (ovigerous female, 6.2 mm); MNHN IU-2014-1042\* (ovigerous female, 6.5 mm); MNHN IU-2013-8839\*# (female, 5.9 mm); MNHN IU-2013-8838 (=NMV J71763)\* (ovigerous female, 6.7 mm). Kavieng Harbour, 02° 34.7' S, 150° 47.5' E, 1–2 m (stn KZ16), MNHN IU-2014-2778 (ovigerous female, 5.4 mm). **Saudi Arabia**, Red Sea, Farasan I., Tiger Head I., 16.79097° N, 42.19865° E, karstic shore, 1–10 m (stn SAFA-024), UF 36051 (ovigerous female, 5.5 mm). Gulf of Aqaba, Joey's Shipwreck Bay, 28.184617° N, 34.638117° E, 3–10 m, seagrass (stn NORS-17B), UF 38165 (female, 4.7 mm). **Indonesia**, Maluku Tenggara, MNHN IU-2016-8089 (ovigerous female, 6.2 mm). Pulu Maratua, E Kalimantan, MNHN IU-2016-8092 (female, 6.0 mm).

**Diagnosis.** Telson 1.35 times as wide as long, with dorsal transverse row of long setae and 3 pairs of spiniform setae, anterolateral lobes rounded, lateral margins tapering to angular posterolateral corners; posterior margin almost truncate. Uropodal endopod 1.7 times as long as wide, with 4 or 5 scattered spiniform setae on face, without spiniform setae along anterodistal margin; anterior margin with or without subdistal tooth. Uropodal exopod 1.2 times as long as wide, distal margin at right angles to anterior margin, dorsal plate comprising numerous dense spiniform setae, anterior margin without distal spiniform seta. Maxilliped 3 ischium 1.0–1.2 times as long as wide; merus almost semicircular.

**Variation.** While most specimens from Papua New Guinea resemble Komai et al.'s (2014) figures, the chelipeds of some differ. The carpus of the major cheliped is shorter, the palm more swollen, and the dactylus with a basal molar in some (cf.

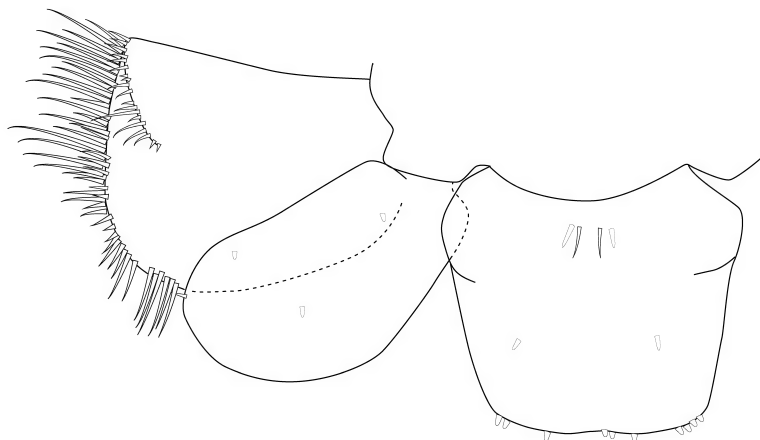


Figure 53. *Spinicallianassa parvula* (Sakai, 1988). Australia, North West Shelf, NTMAG Cr000783, holotype female, 4.0 mm: pleomere 6, telson, uropod.

figs 56a, b with 56l, m). The short distolateral carina on the upper margin of the minor cheliped is more exaggerated in some than others (cf. figs 56d, 56o). Komai et al. (2014) did not observe this carina.

*Colour.* Carapace and pleon essentially translucent/white; very pale orange over anterior carapace. Chelipeds carpi, palms and dactyli with pale reddish-orange dots on mesial and lateral faces (fig. 54). See too Komai et al. (2014: fig. 8).



Figure 54. *Spinicallianassa spinicauda* (Komai, Maenosono and Fujita, 2014). Papua New Guinea. MNHN IU-2014-1042, ovigerous female, 6.5 mm (colour photographs by Zdeněk Ďuriš).

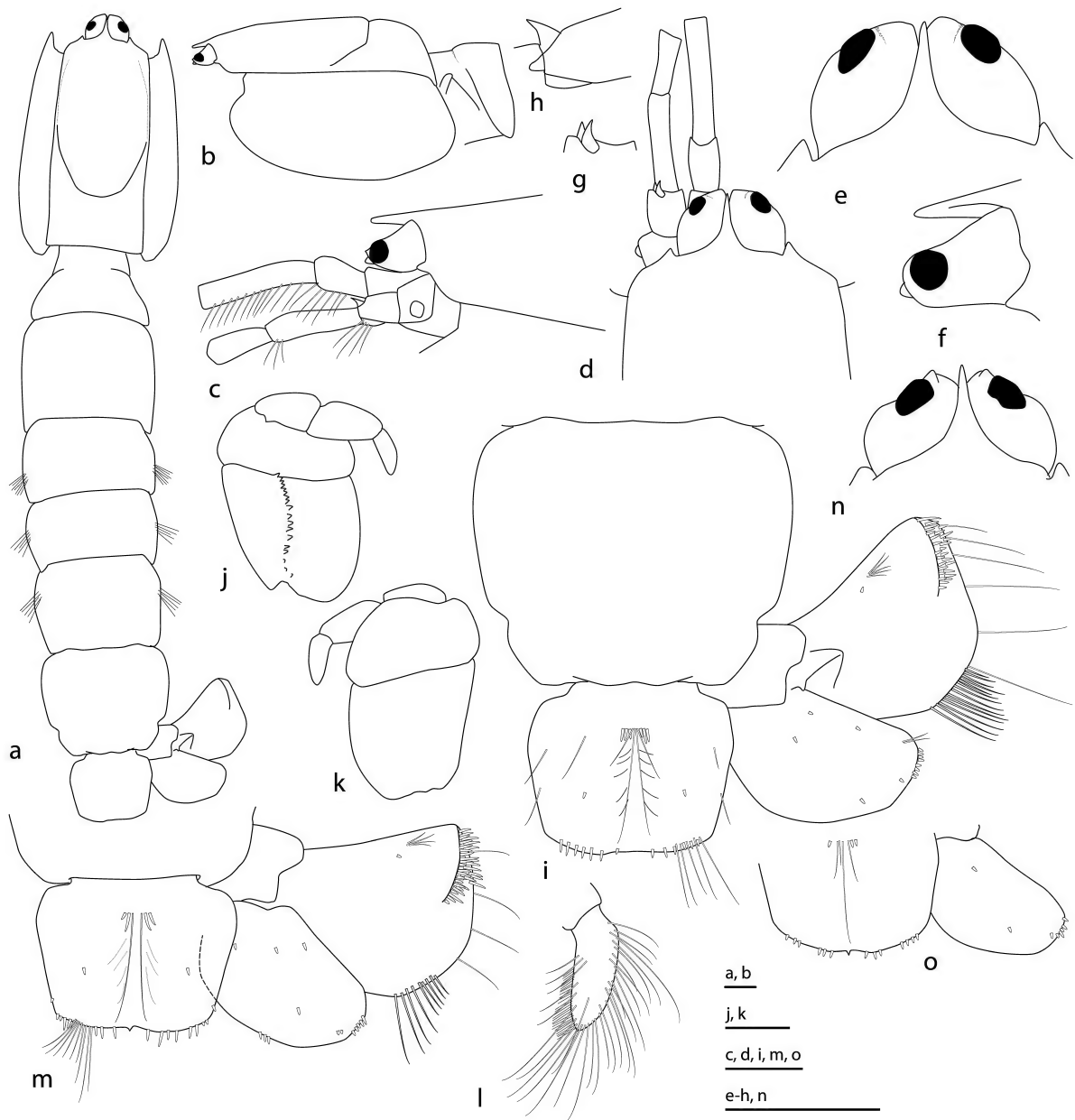


Figure 55. *Spicallianassa spinicauda* (Komai, Maenosono and Fujita, 2014). Papua New Guinea. MNHN IU-2013-7064, female, 7.5 mm: a, eyestalks, carapace, pleon, telson, uropod; b, eyestalk, carapace, pleomere 1 (lateral); c, d, anterior carapace, eyestalk, antennular, antennal peduncles (lateral, dorsal); e, f, eyestalks (dorsal, lateral); g, h, scaphocerite (dorsal, lateral); i, pleomere 6, telson, right uropod; j, k, maxilliped 3 (inner, outer); l, maxilliped 3 dactylus. MNHN IU-2013-7083, female, 6.9 mm: m, telson, uropod. Saudi Arabia, UF 36051, ovigerous female, 5.5 mm: n, eyestalks (dorsal); o, telson, uropodal endopod. Scale bars = 1 mm.



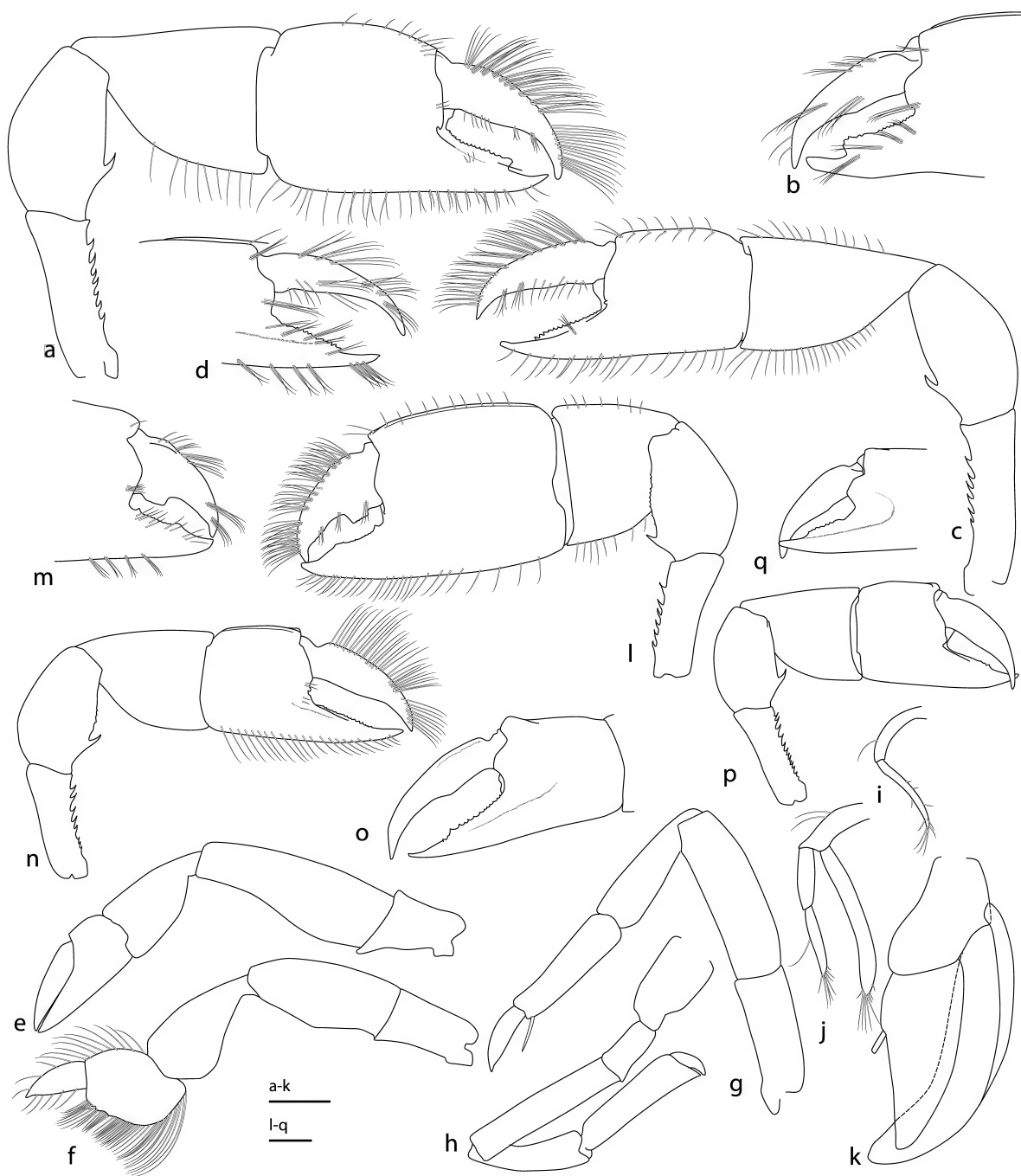


Figure 56. *Spicallianassa spinicauda* (Komai, Maenosono and Fujita, 2014). Papua New Guinea. MNHN IU-2013-7064, female, 7.5 mm: a, major cheliped (left, mesial); b, major cheliped, distal palm, fingers (lateral); c, minor cheliped (right, mesial); d, minor cheliped, distal palm, fingers (lateral); e–h, pereopods 2–5; i–k, pleopods 1–3. MNHN IU-2013-7083, female, 6.9 mm: l, major cheliped (right, mesial); m, major cheliped, distal palm, fingers (lateral); n, minor cheliped (left, mesial); o, minor cheliped, distal palm, fingers (lateral). Indonesia. MNHN IU-2016-8089, female, 6.0 mm: p, major cheliped (left, mesial); q, major cheliped, fingers (lateral). Scale bars = 1 mm.

**Distribution.** Eastern Coral Triangle, Red Sea and Gulf of Aden (Japan, Okinawa [type locality], Philippines, Papua New Guinea, Saudi Arabia); 1–12 m.

**Remarks.** Six specimens in the molecular phylogram (Robles et al., 2020) came from Papua New Guinea (listed above) with one (NHMW 25368\*) from Palawan, Philippines. Dworschak (2022) confirmed the latter and others from the Philippines, Japan, and the Red Sea as *S. spinicauda*. The ovigerous female collected in the Arafura Sea by the *Galathea* expedition, reported and illustrated by Sakai (2005) as *C. acutirostella* is more likely to be *S. spinicauda*. About one quarter of an Australian Museum collection of about 40 callianassids from the Arafura Sea were incomplete or damaged and could not be reliably identified – none appeared to belong to the same species as the *Galathea* specimen.

While close to *S. acutirostella*, *S. spinicauda* differs in having a broader uropodal rami, the endopod with several small facial spiniform setae (two only in *S. acutirostella*) and the maxilliped 3 merus twice as wide as long (1.5 times in *S. acutirostella*). The two females from Saudi Arabia in this collection could not be distinguished from the many specimens from Papua New Guinea, consistent with the view of Dworschak (2022). Only females have been collected.

***Spinicallianassa westralia* sp. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:941976E5-CABA-4F59-A8BA-6EFAC22483DC>

Figures 57, 58

*Callianassa* sp. MoV 4963.—Poore et al., 2008: 94.

**Material examined.** Holotype. **Australia**, WA, off Jurien Bay, 29.8069° S, 114.431° E, 114 m (CSIRO stn SS10/2005/083), NMV J53456 (female, 3.5 mm). Paratype. Australia, WA, North West Shelf, Imperieuse L23 transect, 18° 27.37' S, 120° 08.41' E, 80 m (CSIRO stn SS05/2007/82), NMV J71759 (ovigerous female, 3.3 mm).

**Diagnosis.** Telson 1.2 times as wide as long, with dorsal transverse row of long setae and 1 or 2 pairs of spiniform setae, 1 pair of sublateral spiniform setae, anterolateral lobes rounded, lateral margins tapering to slightly rounded posterolateral corners; posterior margin convex with slight medial concavity. Uropodal endopod 1.9 times as long as wide, with 5 well spaced spiniform setae on face, with 3 or 4 along anterodistal margin; anterior margin with small subdistal tooth. Uropodal exopod 1.7 times as long as wide, distal margin convex, dorsal plate comprising 5–7 spiniform setae, anterior margin with 3 distal spiniform setae. Maxilliped 3 ischium twice as long as wide; merus almost semicircular.

**Description of holotype.** Rostrum triangular, situated at level of dorsal carapace, 0.65 length of eyestalk. Carapace dorsally weakly convex in lateral view; orbital margin transverse, curving into sides of rostrum; anterolateral lobe prominent; subanterolateral margin almost horizontal; anterior margin of branchiostegite convex; cervical groove deeply incised, across 0.85 length of carapace, not reaching linea thalassinica.

Eyestalk 0.8 as wide as long, with dorsal face depressed anteriorly (basally about three quarters as high as wide), with

rounded ventrolateral margin, lateral margins almost parallel proximal to cornea, anteromedial angle asymmetrically rounded in dorsal view, with slight depression medial-distal to cornea, reaching distal margin of antennular peduncle article 1. Cornea densely pigmented, occupying mid-distal of eyestalk.

Antennular peduncle little longer than antennal peduncle; article 1 visible in dorsal view; article 3 longer than articles 1 and 2 combined; article 2 with dense longitudinal ventral row of long setae; article 3 with well-spaced ventral setae. Antennal peduncle article 5 0.7 length of article 4; scaphocerite acute, curved.

Maxilliped 3 ischium dilating distally, 1.2 times as long as wide, crista dentata comprising about 16 small, unevenly spaced teeth; merus 0.5 length of ischium measured along outer margin, 1.5 times as wide as long, with mesiodistal margin convex, overreaching articulation of carpus; carpus as long as merus outer margin; propodus ovoid-tapering, 1.7 times as long as wide; dactylus tapering, shorter than propodus, with scattered setae along upper margin, dense row of short setae along distal lower margin.

Pereopods 1 (chelipeds) unequal, dissimilar. Major cheliped carpus-palm upper margin as long as carapace. Ischium expanding distally, upper margin almost straight, unarmed; lower margin with row of 7 similar oblique spines. Merus 0.8 length of ischium, 1.7 times as long as wide (tooth excluded), ovate; upper margin convex, unarmed; lower margin with oblique spine proximal one third way along margin. Carpus almost as long as wide; upper margin carinate; lower margin carinate. Propodus upper margin 1.5 times as long as carpus; palm 1.2 times as long as wide; upper margin convex, carinate over entire length; lateral surface smooth, convex, with ill-defined depression at base of finger; distolateral margin of palm with lower angle; mesial surface convex, distomesial margin transverse, set back from distolateral margin, with tubercle at lower limit; lower margin carinate, with row of setae extending onto fixed finger; fixed finger 0.65 length of palm, triangular; cutting edge lateral, with steep step before distal concavity. Dactylus slightly overreaching fixed finger, curved, with acute tip; upper margin ridged, with dense tufts of long setae; lateral surface with few tufts of long setae along cutting edge; cutting edge unarmed.

Minor cheliped carpus-palm upper margin 0.75 carapace length. Ischium upper margin smooth, lower margin with row of 5 similar oblique spines. Merus about as long as ischium; lower margin unarmed. Carpus wider distally, 1.1 times as long as merus, twice as long as wide, upper and lower margins carinate. Palm 1.25 times as long as wide; upper margin convex, carinate; lateral face convex, without ridge leading onto finger; lower margin not carinate, with row of long setae extending onto fixed finger; distomesial margin oblique, with obsolete tubercle at lower limit. Fixed finger 0.75 length of palm, cutting edge smooth. Dactylus tapering, curved, unarmed.

Pereopod 2 merus lower margin slightly sinusoidal, 2.8 times as long as wide; carpus 1.8 times as long as wide; chela subtriangular; palm about 1.4 times as wide as upper margin; dactylus twice as long as palm upper margin. Pereopod 3 carpus subtriangular, twice as long as wide; propodus oval, upper margin convex, 1.2 times as long as greatest width,

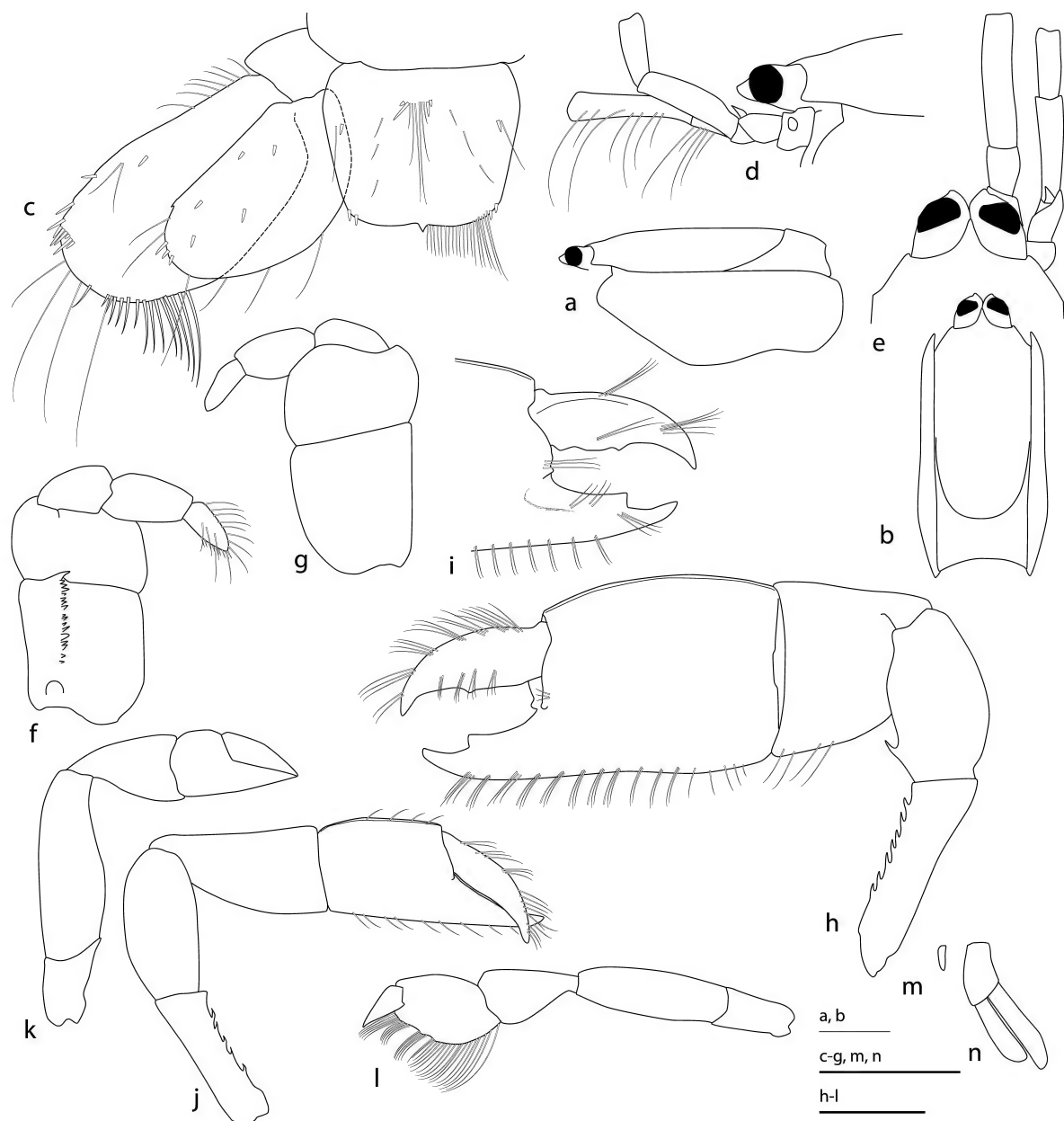


Figure 57. *Spinicallianassa westralia* sp. nov. Australia, WA. NMV J53456, holotype female, 3.6 mm: a, b, eyestalks, carapace (lateral, dorsal); c, telson, uropod; d, e, antennular, antennal peduncles, eyestalks, anterior carapace (lateral, dorsal); f, g, maxilliped 3 (inner, outer views); h, major cheliped (right, mesial view); i, major cheliped fingers (lateral); j, minor cheliped (left, mesial view); k, l, pereopods 2, 3; m, n, pleopods 1, 2. Scale bars = 1 mm.

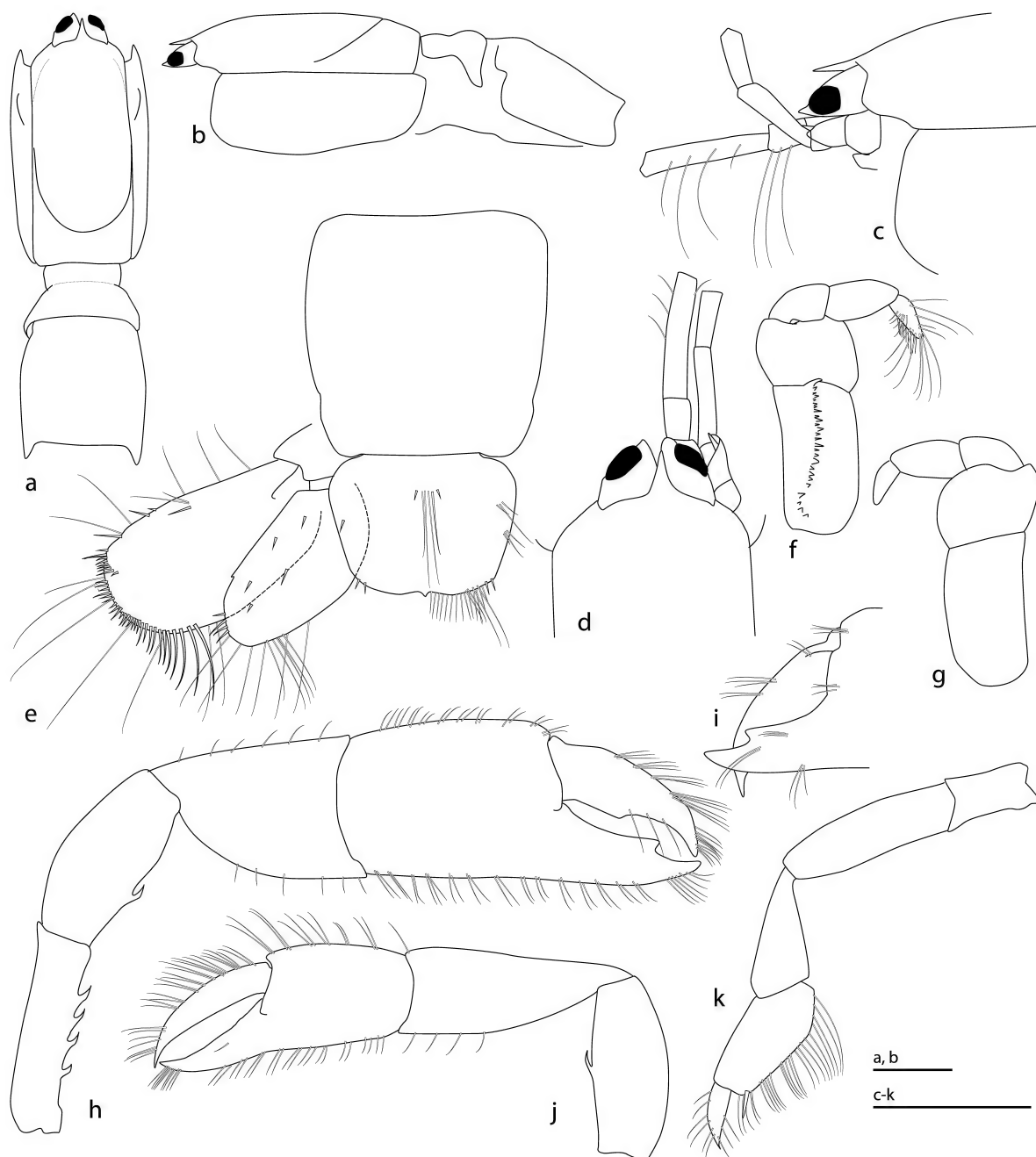


Figure 58. *Spinicallianassa westralia* sp. nov. Australia, North West Shelf, NMV J71759, paratype ovigerous female, 3.3 mm. a, b, eyestalks, carapace, pleomeres 1, 2 (dorsal, lateral); c, d, antennular, antennal peduncles, eyestalk, anterior carapace (lateral, dorsal); e, pleomere 6, telson, left uropod; f, g, maxilliped 3 (inner, outer); h, major cheliped (left, mesial); i, major cheliped fingers (lateral); j, minor cheliped (right, mesial); k, pereopod 3. Scale bars = 1 mm.

lower margin convex, with lower proximal margin not produced, with 1 slender subdistal spiniform seta, with gaps between clusters of marginal setae; dactylus nearly straight, shorter than propodus upper margin. Pereopods 4, 5 missing.

Pleopod 1 minute, uniarticulate. Pleopod 2 biramous, small, without setae.

Uropod endopod and exopod overreaching posterior margin of telson. Endopod oval, widest near midpoint, 1.8 times as long as wide; upper surface with 5 small spiniform setae (2 on dorsal rib, 2 near anterior margin, 1 near posterior margin); anterior margin straight, with minuscule distal tooth; distal margin evenly convex, with 3 spiniform setae near anterodistal margin; posterior margin convex, setose. Exopod widest near midpoint, 1.8 times as long as wide; anterior margin slightly convex, with 3 separated spiniform setae; with about 14 blade-like setae on posterior margin indistinguishably merged with distal margin; dorsal plate extending one quarter way across exopod, with few stiff setae merging with those on distal margin; distal and posterior margins also furnished with row of fine setae; upper face with 1 small spiniform seta and 2 fine setae near anterior margin.

Telson 1.2 times as wide as long, broadest at anterior third, narrowing posteriorly to obtusely rounded posterolateral corners, each with 2 spiniform setae; posterior margin medially excavate, setose; dorsal surface with transverse row of 4 medial fine long setae plus 2 pairs (1 pair in paratype) of spiniform setae, 2 submedial longitudinal rows of very fine setae, scattered fine setae, 1 sublateral pair of spiniform setae and accompanying fine seta.

**Variation.** The paratype has a narrower major cheliped and narrower maxilliped 3.

**Etymology.** Contraction of Western Australia, where the species is found (noun in apposition).

**Distribution.** West Central Australian Shelf (Australia, WA), 80–114 m.

**Remarks.** The uropodal exopod of *Spinicallianassa westralia* is narrower than in other species of the genus and is characterised by two long marginal spiniform setae and one submarginal on the anterior margin; the dorsal plate comprises few setae and extends only a small fraction across the exopod.

### ***Trypaea* Dana, 1852**

*Trypaea* Dana, 1852. – Poore et al., 2019: 100 (redagnosis, synonymy).—Poore and Ah Yong, 2023: 214.

**Remarks.** Sakai (2011) used the genus name *Trypaea* for eight species from the Eastern Pacific Ocean, five species from the North and Western Atlantic Ocean, and 40 species from elsewhere, mostly from the Indo-West Pacific. As Poore et al. (2019) and Robles et al. (2020) showed, the only species of *Trypaea* is *T. australiensis* Dana, 1852, restricted to southeastern Australia, where it is the most common intertidal estuarine and marine species of callianassid (Poore, 2004). The genus does not occur in the Indo-West Pacific.

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## A new species of *Planipapillus* (Onychophora: Peripatopsidae) that defies the original concept of its genus

<https://zoobank.org/References/696362CC-6181-4898-B790-A3480DB7C0D1>

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### Abstract

Douch, J.K. and Reid, A.L. 2023. A new species of *Planipapillus* (Onychophora: Peripatopsidae) that defies the original concept of its genus. *Memoirs of Museum Victoria* 82: 257–262.

*Planipapillus* Reid, 1996 (Onychophora: Peripatopsidae) is a genus of peripatus or velvet worms from south-eastern Australia, consisting of 12 nominal species, unique in having a patch of reduced papillae on the heads of males. Specimens from Mt Useful, Victoria, that lack this trait were identified as a species of *Planipapillus* on the basis of morphological and molecular analyses in 1999 and 2001, respectively. That species is herein described as *P. absonus* sp. nov., and an emended diagnosis for the genus is provided to accommodate this unusual addition. The relationship between modified head papillae and mating is discussed.

### Keywords

Mt Useful, Peripatopsidae, Onychophora, *Planipapillus*, species description, taxonomy

### Introduction

*Planipapillus* Reid, 1996 (Onychophora: Peripatopsidae) is a genus consisting of 12 nominal species, unique in having a patch of reduced papillae located posterior to the eyes on the heads of males, in addition to distinct male reproductive tract morphology. In some species this patch is equipped with sclerotised spikes and the papillae along the margin of the patch may be enlarged. All members are oviparous and endemic to parts of eastern Victoria or south-eastern New South Wales, Australia (Reid, 1996; 2000b).

Collections made in 1999 (AR) at Mt Useful, in the Great Dividing Range of eastern Victoria, were initially recognised as a distinct species of *Planipapillus*, but have languished in a museum collection awaiting description for over two decades. In 2001, onychophorans were collected and sequenced from a variety of locations, including Mt Useful (Rockman et al., 2001). Analysis of the cytochrome c oxidase subunit 1 (*COI*), 12S rRNA (*12S*), and *fushi tarazu* (*Ftz*) genes showed that the Mt Useful specimens belong to an undescribed species, reported as “*Planipapillus* sp. 5”, in the genus *Planipapillus*, despite the males lacking the characteristic patch of reduced papillae. This was noted by Rockman et al. (2001), who assigned the absence of modified head papillae to a character state they termed “class

6”. While it appears that no vouchers from the 2001 study were formally lodged in an accessible repository, and the 1999-collected specimens were formalin-fixed so not readily amenable to sequencing, it seems highly likely that the sequenced specimens belong to the same taxon as those first collected in 1999. Because onychophorans are very narrow-range endemics (Bull et al., 2013; Harvey, 2002) and the likelihood of more than one *Planipapillus* species without modified head papillae occurring at a single location is exceedingly low, it is probable that the species described below is conspecific with the *P.* sp. 5 of Rockman et al. (2001). In addition to the molecular sequence data, the male reproductive tract morphology and colour pattern support the placement of this taxon in *Planipapillus*. The generic diagnosis is modified to accommodate this taxon and the species is fully described below.

### Methods

Two male and four female Mt Useful *Planipapillus* specimens belonging to the collections of Museums Victoria (MV), Melbourne, were examined. All were fixed in formalin and preserved in 70% ethanol.

Two specimens were sampled to produce additional molecular data. One leg of each was excised, avoiding the two



hind legs that feature the diagnostically important anterior and posterior accessory glands. Samples were then pre-treated with a double-wash of phosphate-buffered saline. Extractions were performed using the DNeasy Blood & Tissue Kit (QIAGEN) according to the manufacturer's protocol. Polymerase chain reaction (PCR) of the genes *COI*, *12S*, *18S* rRNA (*18S*), and *28S* rRNA (*28S*) was then attempted using primers previously demonstrated to be effective for peripatopsid samples (Folmer et al., 1994; Hering, pers. comm.). The following thermocycling conditions were used in PCR: 98°C for 10 min; 40 cycles of 98°C for 45 s, 49°C for 45 s, and 72°C for 1 min; and finally, 72°C for 5 min. Production of amplicons of the expected size was checked using 1.5% agarose gel electrophoresis with GelRed nucleic acid stain. None of the four PCR reactions of either sample produced any amplicons.

Specimens were immersed in a dish of ethanol for morphological analysis by stereomicroscopy. Head width (HWE) was measured dorsally as the distance between the midpoint of each eye, and the eye diameter index (EDI) was calculated by dividing eye diameter by HWE (*cf.* Reid, 1996). Image-stacking of stereomicrographs was used to produce images that captured all focal planes (fig. 1). Features of the male reproductive tract were hand-drawn based on examination using a stereomicroscope fitted with a gridded graticule (fig. 2). To visualise the ultrastructure of taxonomically important characters, tissues were excised, mounted on an adhesive stub, air-dried and gold-sputtered, prior to imaging with a tungsten variable pressure scanning electron microscope (JEOL 6480LA) at the Macquarie University Microscopy Laboratory (fig. 1).

## Systematics

### *Planipapillus* Reid, 1996

**Diagnosis** (emended from Reid, 2000b). Colour pattern: longitudinal light-coloured band along dorsal midline and short, dark, transverse bars or blotches along midline dorsal to legs; light dorsolateral transverse patches in line with legs and light patches laterally between legs (components are variably present within and among species). Males with or without an ovoid patch of reduced papillae posterior to eyes. Females with or without crural papillae. Oviparous.

### *Planipapillus absonus* sp. nov.

<https://zoobank.org/NomenclaturalActs/CE8B797D-A435-4F76-A4F5-3677B5EF2055>

Figures 1–3

**Material examined.** Holotype 1♂, Victoria, Mount Useful Natural Features and Scenic Reserve, 14.5 km N of intersection of Binns Rd & McEvoy's Tk, 37° 43' S, 146° 31' E, 1108 m, 3 Apr 1999, coll. A. Reid and R. Roberts (MV K7279). Paratypes 1♂ 4♀, data as for holotype (MV K7280).

**Diagnosis.** Body with pale longitudinal mid-dorsal stripe, punctuated by pale transverse stripes dorsal to each leg pair. Dark blotches present at each stripe intersection. Antennal rings

banded. Without ovoid patch of reduced papillae on head of males or females. Anterior accessory glands and gland papillae present. Posterior accessory glands straight.

**Description.** Measurements. HWE males 0.77–0.81–0.84 mm ( $n = 2$ , holotype 0.84 mm HWE); HWE females 0.90–1.13–1.31 mm ( $n = 4$ ).

**Colour pattern.** Ground colour caerulean (fig. 1a), olivaceous, or pale yellow with evenly scattered black papillae (fig. 1b–d). Pale, mid-dorsal longitudinal stripe extends posteriorly from base of head along length of body, with pale, transverse stripes and dark blotches dorsal to each leg pair along dorsal midline (fig. 1a, b). Legs paler than dorsum, with pale patches at junction with feet. Papillae around anal opening pigmented as for rest of ventrum. Ventral pigment ivory white (fig. 1c). Spinous pads pale yellow or pale olivaceous. Integument between genital and anal openings pigmented as for rest of ventrum.

**Antennal rings.** Antennal rings banded dorsally, varying between ground colour and slightly darker than ground colour (fig. 1a–d). Distal 7–9 antennal rings with sensory bulbs; sensory pads with one row of sensilla.

**Eyes.** EDI males 0.07–0.08–0.08 mm ( $n = 2$ , holotype 0.08 EDI); EDI females 0.07–0.07–0.08 mm ( $n = 4$ ).

**Head (males).** No modification of head papillae (fig. 1b, d).

**Head (females).** No modification of head papillae.

**Dorsal integument.** Males with 11–11.5–12 ( $n = 2$ , holotype 11), females with 12.0–14.8–17.0 ( $n = 4$ ) papillae counted from mid-dorsal line to junction of leg 10. Primary papillae dome-shaped (fig. 1e), approximately equidistant, interspersed by at least one secondary papilla (fig. 1f).

**Male reproductive tract.** Male genital pad cylindrical, protuberant. Proximal vasa efferentia separate, do not lie parallel before fusing to form vas deferens; vas deferens projects anteriorly before looping posteriorly to gonopore.

**Male glands and gland papillae.** Crural papillae on ventral side of legs 2–8 and 11–14. Papillae shape differs among legs: semicircular or cylindrical proximally, tapered abruptly to narrower, semicircular or cylindrical distal section (legs 2–8; fig. 1g) or subconical, low, not divided into distinct basal and distal regions (legs 11–14). Crural glands straight, elongate, not folded (fig. 2). Anterior accessory glands and gland papillae present. Posterior accessory glands curved, bulbous, blunt distally (fig. 2).

**Female crural papillae.** Absent.

**Legs.** Two relatively short claws. Nephridiopores intersect third spinous pad on ventral side of legs 4 and 5 (fig. 1h), openings broad U-shaped with smooth distal margin (fig. 1h, i).

**Etymology.** The specific epithet *absonus*, Latin for “discordant”, refers to the lack of reduced head papillae posterior to the eyes in males of this species, controverting what was previously thought to be a consistent and defining feature of the genus *Planipapillus*.

**Distribution.** This species is known only from the type locality (fig. 3).

**Habitat.** Under log in montane damp forest, with canopy dominated by species of *Eucalyptus* L'Hér.

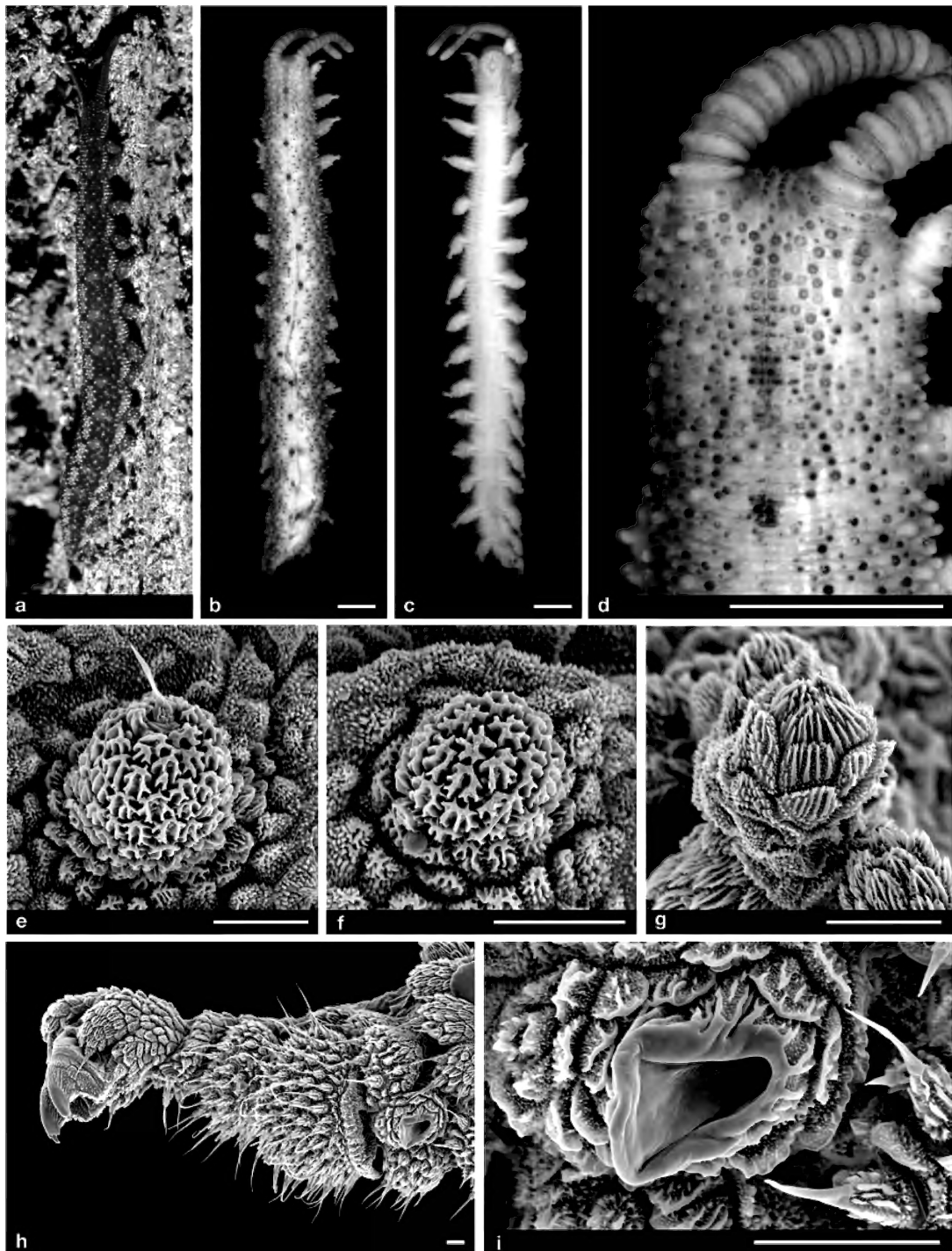


Figure 1. *Planipapillus absonus* sp. nov.: a, dorsolateral view *in natura*, ©David Paul; b, dorsal view; c, ventral view; d, anteriodorsal view; e, primary papilla; f, secondary papilla; g, crural papilla, leg 6; h, leg 5; i, nephridiopore, leg 5. b–d, stacked stereomicrographs, holotype ♂ 0.84 mm HWE (MV K7279), scale bars = 1 mm; e–i, scanning electron micrographs, paratypes MV K7280, scale bars = 30  $\mu$ m; e, f, h, i, ♀ 1.04 mm HWE; g, ♂ 0.77 mm HWE.

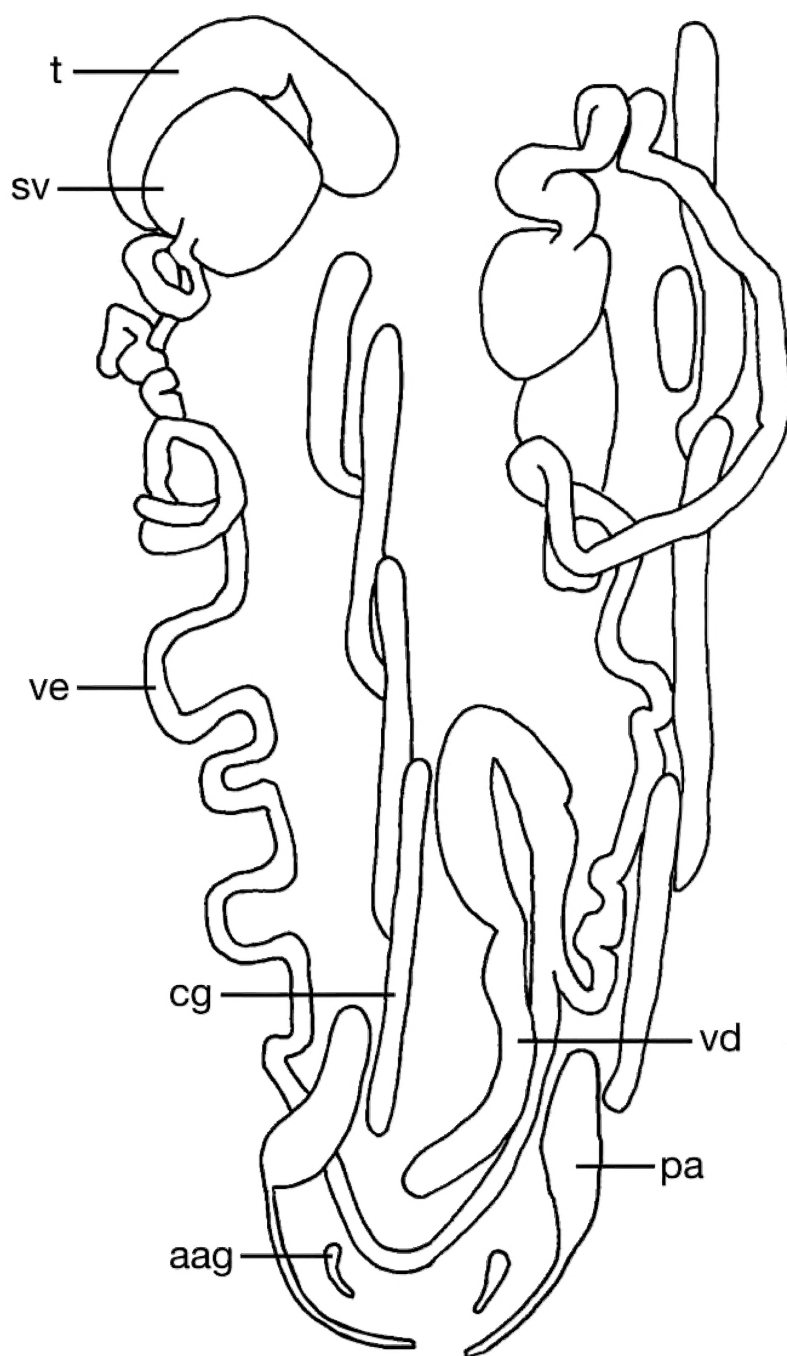


Figure 2. *Planipapillus absonus* sp. nov.: male reproductive tract and associated glands, composite image drawn from holotype and paratype male. aag, anterior accessory gland; cg, crural gland; pa, posterior accessory gland; sv, seminal vesicle; t, testis; vd, vas deferens; ve, vas efferens.

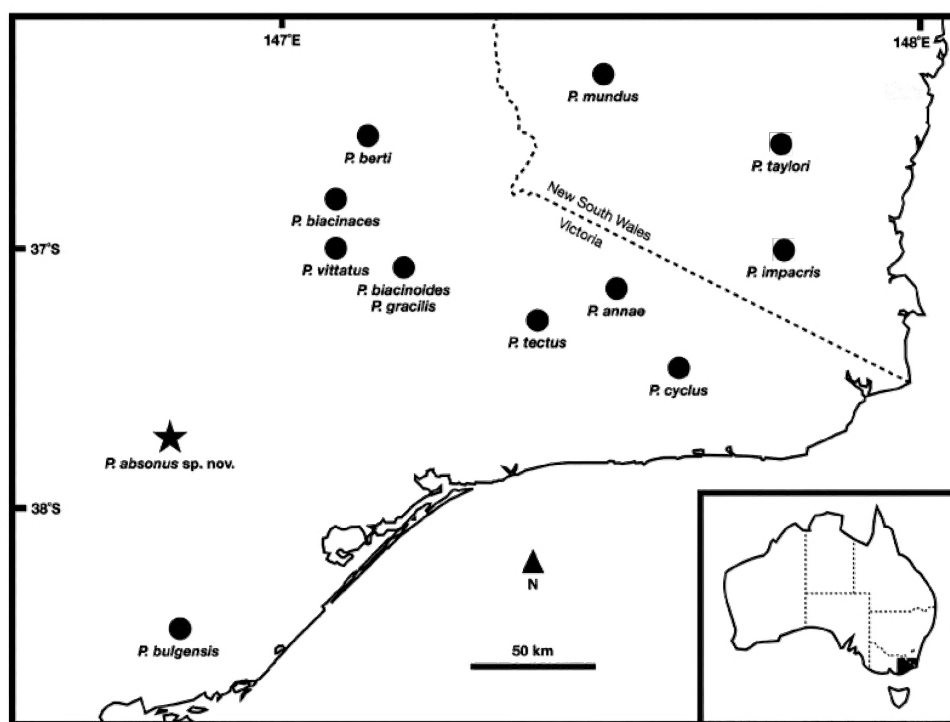


Figure 3. Map of eastern Victoria and south-eastern New South Wales, Australia, indicating the type locality of *Planipapillus absonus* sp. nov. (★) among the type localities of all nominal congeneric species (●).

**Remarks.** This species is referred to as *P. sp. 5* by Rockman et al. (2001), who demonstrated its membership in the genus *Planipapillus* via analysis of *COI*, *12S*, and *Ft2* nucleotide sequences (GenBank accession numbers AF337991, AF338008, and AF338028, respectively). The authors state that “DNA preparation and scanning electron microscopy (SEM) are destructive, but wherever possible voucher specimens of both sexes were lodged at the Australian Museum in Sydney”. DNA preparation would not have required the destruction of an entire individual, and no electron micrographs of *P. sp. 5* are presented in the article. Despite this, no specimens from which the aforementioned sequences were obtained could be located in the Australian Museum.

## Discussion

This study describes a new species of onychophoran, a member of a unique and relatively species-poor animal phylum. This species is distinct and it is an outlier within *Planipapillus*, broadening the concept of this genus.

The species is the second onychophoran to be described from Mt Useful, the first being *Ooperipatus porcatus* Reid, 2000. The two can be readily distinguished in the field, because the dorsal pigmentation pattern of the former consists of a longitudinal stripe intersected by short transverse stripes, whereas the latter sports a longitudinal series of jointed

diamonds (Reid, 2000a), as is typical of their respective genera. The two species existing in at least partial sympatry suggests that they do not occupy identical niches. The ecology of both species is totally unstudied, so whether these taxa occupy distinct ecological niches or exhibit some form of habitat and resource partitioning is unknown.

Head-to-tail insemination has been observed in *P. annae* (Reid, 2000b) and *P. mundus* (cf. iNaturalist observation #189625912). This mode of insemination involves the male bearing sperm on its head and placing it over the female's genital opening. It is possible that the pad of reduced papillae on the heads of these species, in some way functions either to hold the sperm in place and/or plays a role in species recognition. It is not known at this time whether all *Planipapillus* species use this same mode of insemination, but it would be interesting to see whether it is also true for *P. absonus* despite its lacking modified head papillae.

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